Draft Anadromous Fish Restoration Plan

A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California

DRAFT ANADROMOUS FISH RESTORATION PLAN

A PLAN TO INCREASE NATURAL PRODUCTION OF ANADROMOUS FISH IN THE CENTRAL VALLEY OF CALIFORNIA

Prepared by the United States Fish and Wildlife Service
for the Secretary of the Interior under the direction of the
Anadromous Fish Restoration Program Core Group

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PREFACE

The Central Valley Project Improvement Act (CVPIA), requires the Secretary of the Interior to develop and implement "a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967-1991" (Section 3406[b][1]). This program is known as the Anadromous Fish Restoration Program (AFRP).

The AFRP is proceeding in three general phases: 1) production of the Working Paper, 2) production of the Restoration Plan, and 3) implementation of the plan. The primary product from the first phase is the Working Paper. The Working Paper documents actions needed to at least double natural production, but does not consider whether or not these actions were reasonable. The second phase considers whether actions are reasonable, and focuses on production of a reasonable restoration plan. The third phase focuses on implementation, some of which is currently underway.

This document marks a midpoint in the second phase of the program, and is the first draft of the Anadromous Fish Restoration Plan. For this plan, reasonable actions were selected from those described in the Working Paper and additional actions suggested by the public, other interested parties, and public and private agencies.

We tried to be as specific as possible when we described individual actions. We will develop more detailed descriptions of all actions and to make these available to the public, either as part of the final restoration plan or under a separate cover. Drafts of these detailed descriptions for select actions will be available for review prior to release of the final draft of this plan.

To select reasonable actions, we considered all comments received from the public and revised actions as needed to address these comments; we applied the process and criteria for identifying reasonable actions; we recommended evaluations where insufficient information existed to identify reasonable actions; and emphasized the cooperative nature of the restoration efforts.

In an effort to include only reasonable actions, we believe the program will fall short of doubling natural production for all species and races of anadromous fish. Additional actions will be necessary to double nautral production of all anadromous fish species. These actions will be identified as a result of the evaluations listed in this plan, or as a result of monitoring and evaluation associated with implementation of individual actions.

The restoration of anadromous fish production in Central Valley rivers and streams is anticipated to be a complex weave of improved water quality, increased water quantity

during critical life-history periods, moderation of the detrimental effects of water management and diversion, improved fish passage at natural and human-induced blockages, and many other actions that influence characteristics of the physical habitat required by anadromous fish. Most of the actions in this plan restore the habitat of anadromous fish.

However, anadromous fish production cannot be returned to levels of high abundance with a program that is directed only at habitat. Other factors must be considered and incorporated into the overall restoration program. These non-habitat factors include hatchery practices; including release timing and location, numbers of fish propagated, and disease transmission within and between hatchery and wild stocks; inland harvest; ocean harvest; predation on naturally produced fish; maintaining the genetic integrity of specific stocks; and control of introduced competitor species. Some of the actions in this plan address these non-habitat factors.

One of the overall, long-term strategies of this program is to contribute to ecosystem management. Truly, the success of this program needs to be at the ecosystem level and broader efforts to restore the natural ecosystem functions of the Central Valley are of great importance. Ecosystem functions include emulation of the natural hydrologic cycles, reestablishing large meander belts within many river and stream reaches to permit the recruitment and transport of gravel needed for spawning and food production, the restoration of the natural tidal cycles which influence shallow freshwater and brackish habitats in the Delta, the restoration of riparian forest and shaded riverine aquatic habitats which help moderate water temperatures, provide cover for young fish, and are a source of terrestrial invertebrates, and other such ecosystem functions.

The continuing urbanization of the Central Valley places increasing demands on the environment needed by anadromous fish. Droughts, floods, wild fires, and ocean productivity can also greatly affect production largely independent of habitat restoration and management actions. Although successful implementation of this program can greatly benefit anadromous fish populations, there is a great need to implement actions that can offset or moderate the detrimental effects of natural catastrophic events.

Implementation of the AFRP will not occur in the absence of local, county, or state support. The success of this program will rely heavily on partnerships with individual property owners, watershed conservancies, conservation organizations, county and local governments, and state and federal agencies. Because of the need for these partnerships, most actions selected for implementation will have met a local test of reasonableness.

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INTRODUCTION

The Secretary of the Interior (Secretary) was directed by Congress to develop and implement a program which makes all reasonable efforts to restore and enhance anadromous fish habitat in the rivers and streams of California's Central Valley (excluding the San Joaquin River upstream of Mendota Pool), with the overall target of doubling the natural production of anadromous fish relative to the average levels attained during 1967-1991 (Section 3046(b)(1) of the Central Valley Project Improvement Act (CVPIA); Public Law 102-575). The Secretary has directed the U.S. Fish and Wildlife Service (USFWS) and the U.S. Bureau of Reclamation (USBR), to jointly implement the CVPIA, including Section 3406(b)(1), which has become known as the Anadromous Fish Restoration Program (AFRP). The six anadromous fish species identified for restoration efforts under the AFRP are chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), striped bass (*Morone saxatilis*), American shad (*Alosa sapidissima*), white sturgeon (*Acipenser transmontanus*), and green sturgeon (*A. medirostris*). This program plan presents the goals, objectives, and strategies of the AFRP, and describes the processes that the program will employ to identify, develop, select, and implement restoration actions.

PROBLEM

Since the settlement of the Central Valley in the mid-1800s, populations of native anadromous fishes (i.e., chinook salmon, steelhead, white sturgeon, and green sturgeon) have declined dramatically. At present, winter-run chinook salmon are listed under the federal Endangered Species Act as endangered, while spring-run, late-fall-run and San Joaquin fall-run chinook salmon are described as potential candidates for threatened or endangered status (Moyle et al. 1994), and the National Marine Fisheries Service (NMFS) is presently conducting a status review in response to a petition to list chinook salmon throughout its range (NMFS 1995). The NMFS is also conducting a status review for steelhead in California, Idaho, Oregon, and Washington (NMFS 1994). Green sturgeon, which are considered threatened in Canada, are listed as a species of special concern by the State of California (Moyle et al. 1994).

American shad and striped bass were introduced into the Sacramento-San Joaquin system in the 1870s. Both species supported valuable sport and commercial fisheries throughout much of this century but California Department of Fish and Game (CDFG) data indicate that populations and harvest rates have declined since the mid-1960s.

Intense sedimentation and diversion of water in many streams resulted from hydraulic mining for gold and was probably the first human activity that resulted in large-scale habitat degradation in Central Valley streams. This practice was prohibited in 1894 but habitat degradation has continued in the form of modification of natural hydrologic

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regimes by dams, construction of barriers to upstream migration, water diversions, reduced quantity and quality of instream and riparian habitat, excessive water temperatures, and water pollution. Other factors that may have adversely affected natural stocks of anadromous fish include overharvest, introduction of competitors, predators and disease organisms, and the effects of increased hatchery production. While the effects of habitat degradation on fish populations were evident by the 1930s, rates of decline for most anadromous fish species increased in the period following completion of the major water project facilities.

In addition to human activities, fish populations may decline due to natural events. Droughts and poor ocean conditions, such as El Niño conditions that result in poor survival of anadromous fish, also may reduce populations. However, populations typically recover within a few years after the occurrence of natural catastrophes.

VISION

The AFRP is an opportunity for the USFWS and USBR to work collaboratively with other agencies, organizations and the citizens of California to increase natural production of anadromous fish in the Central Valley by augmenting and assisting restoration presently conducted by local watershed workgroups, the CDFG, and numerous other agencies and groups. Purposes of the CVPIA (Section 3402) relevant to the AFRP are: 1) to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley, 2) to address impacts of the Central Valley Project (CVP) on fish, wildlife, and associated habitats, 3) to contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay and Sacramento-San Joaquin Delta Estuary, and 4) to achieve a reasonable balance among competing demands for the use of CVP water, including the requirements of fish and wildlife, agricultural, municipal and industrial and power contractors.

GOALS

The goal of the AFRP, as stated in section 3406(b)(1) of the CVPIA, is to "...develop within three years of enactment and implement a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967-1991..."

During the first phase of this program, the USFWS released the Working Paper on Restoration Needs (USFWS 1995), which included estimates of production targets for four races of chinook salmon, steelhead, striped bass, American shad, and white and green sturgeon. These estimates are summarized in Table 1.

Table 1. Targets for anadromous fish production in Central Valley rivers and streams.

Species	Target
Chinook salmon, all races[a]	990,000
Fall run	750,000
Late fall run	68,000
Winter run	110,000
Spring run	68,000
Steelhead[b]	13,000
Striped bass	2,500,000
American shad[c]	4,300
White sturgeon	11,000
Green sturgeon	2,000

[a] Appendix B lists production targets for each race of chinook salmon for each of the streams in the Central Valley. Because of rounding errors, targets for individual races of chinook salmon do not add up to the target for all races.
[b] Production target for steelhead spawning upstream of Red Bluff Diversion Dam.
[c] Production target for American shad is expressed as the juvenile index as derived from the CDFG fall midwater trawl in the Delta.

The Working Paper also included a list of restoration actions developed by fishery experts, that, if implemented, would likely result in at least doubling the natural production of anadromous fish. Although the experts did not consider if the actions they identified were reasonable, the purposes of identifying them were to assess the scientific basis for restoration and provide a foundation for practical considerations.

Since the release of the Working Paper, the USFWS has received comments indicating that some of the actions contained in the Working Paper are not reasonable. To address these comments, the USFWS has adopted an incremental approach to restoration. Initially, restoration will be restricted to actions that the USFWS and USBR are given specific authority to implement under the CVPIA, or other reasonable actions that have been identified by the public. Doubling production by implementing a reasonable set of actions is far less certain than implementing all the actions in the Working Paper, but may

still be possible for selected species and streams. For example, doubling production of fall-run chinook salmon in a small tributary of the upper Sacramento River may be relatively easy, whereas doubling production of striped bass will likely be difficult because all life history stages depend on the Delta and the habitat needs for doubling in terms of Delta outflow and export curtailments are unreasonable.

We can only know for sure if production can be doubled after it has been doubled. This is in part why monitoring and evaluating progress toward doubling throughout the implementation process is important. In the long-term, implementation of additional actions will depend upon the results of implementing initial actions and the ability of the USFWS and USBR to work with the public to develop and implement solutions to the problems that limit natural production.

OBJECTIVES

The following general objectives have been identified as necessary steps toward achieving the program goal: 1) improve stream habitat for all life stages of anadromous fish through improved flows, water quality, and physical structure, 2) improve survival rates by reducing or eliminating entrainment of juveniles at diversions, 3) improve adult escapement rates by modifying or eliminating structures that impede migration, 4) develop fish population and habitat data to facilitate evaluation of restoration actions, 5) integrate inland restoration efforts with harvest management, and 6) involve resources of the private sector in the evaluation and implementation of restoration programs.

STRATEGIES

Fishery managers must address complex biological, economic, social, and technological issues to substantially restore natural production of anadromous fish in the Central Valley. Restoration will likely be costly and may necessitate altering the management of aquatic resources and habitats. Success will depend on the participation of partners, coordination of actions with other agencies and programs, and the strong support of the public. Therefore, the AFRP requires a solid strategy to select and implement effective restoration actions. These actions should minimize adverse effects on other uses of natural resources to receive financial and public support.

The AFRP strategy consists of two components, an implementation principle and an implementation approach. The implementation principle is the basic tenet ultimately guiding the selection of actions for implementation. The implementation approach describes essential qualities of restoration actions and how they may be implemented. The following sections on principles and approaches discuss the general foundation for development of an implementation process, the process is discussed in the Implementation Process section of this plan.

Implementation principle

Restoration actions will be selected for implementation based on an evaluation of biological benefits, including those for a target species or race, multiple species or races, and other components of the ecosystem such as natural channel and riparian habitat values.

Biological benefits of restoration actions will be considered based on the following priorities:

1. The magnitude of the benefit and its contribution toward doubling natural production.
2. The status of the target species or race and the urgency of its need for production to be restored.
3. The immediacy and permanence of the anticipated biological benefits.
4. The incidental or conjunctive benefits to protecting biodiversity and other components of the ecosystem.

An action that does not conform to the above priorities could be ranked high if it eliminates a "bottleneck" to fish production. A bottleneck is a limiting factor that prevents benefits of other actions from being realized. An example of a bottleneck is a migration barrier that negates the potential benefits of improving spawning habitat upstream. Other limiting factors that may act as bottlenecks include degraded water quality, high water temperatures, poor conditions in the Delta, and overharvest.

The four priorities tend to direct restoration actions toward streams that have suffered the greatest habitat degradation and reduction of anadromous fish production because:

- Degraded streams are likely to show greater magnitudes of contribution toward doubling than healthy streams simply because there is less room for improvement on healthy streams.
- Degraded streams are likely to need protection for the remaining depleted populations of target species.
- As a consequence of the previous two statements, degraded streams are likely to show immediate responses to restoration actions.
- Degraded streams are apt to have suppressed populations of multiple species whereas a healthy stream with suitable habitat and few anadromous fish is likely the result of some migratory barrier.

The fourth priority considers the ecosystem benefits of actions, such as improvements to habitat and non-target species. An intent of the CVPIA is to promote natural habitats because it directs the AFRP to "...give first priority to measures which protect and restore

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natural channel and riparian habitat values through habitat restoration actions...[Section 3406(b)(1)(A)]." Reinforcing direction toward actions that establish natural habitats is given in other portions of the CVPIA, such as to re-establish meander belts to avoid losses of instream and riparian habitats [Section 3406(b)(13)], investigate measures to provide suitable water temperatures for anadromous fish by restoring riparian forests [Section 3406(e)(1)], and develop models to evaluate channel maintenance flows to restore natural channel and riparian habitat values [Section 3406(g)(5)].

Restoring habitat values promotes natural processes regulating the geomorphic characteristics, nutrient dynamics, and biological production capabilities of streams. These processes ultimately influence the ability of both the physical and biological components of the ecosystem to respond to environmental changes or perturbations. These include the ability to resist abrupt fluctuations in production or habitat structure and the capacity to return to preexisting conditions after a perturbation. The ability of fish production to resist change and recover from perturbations contributes to long-term sustainability of natural production. Examples of actions that promote natural habitat values include establishing stream flow patterns that mimic the natural hydrologic regime to protect specific life history stages of anadromous fish, maintaining adequate habitat features, and providing migratory cues; managing reservoir water releases for appropriate water temperatures to reduce thermal stress and direct mortality; restoring stream channels and riparian areas to provide adequate habitat and reduce sources of contaminants and effluents that degrade water quality; and establishing suitable spawning areas to compensate for those degraded or inaccessible due to dams.

The implementation principle allows the AFRP to examine the relative merits of implementing actions on a case-by-case basis. This is especially useful in comparing alternative actions that address a common limiting factor as well as comparing actions that address different limiting factors. In applying the principle, the AFRP will generally support actions that contribute to increasing the natural production of anadromous fish through restoration of natural habitat values before supporting actions that increase production by other means.

Implementation approach

An approach is a method employed to attain a desired effect. The AFRP must ensure that methods employed to implement restoration actions possess certain qualities so that they make all reasonable efforts to double natural production of anadromous fish. These qualities include partnerships, local involvement, public support, adaptive management, and flexibility.

Partnerships

Making all reasonable efforts to double natural production of anadromous fish throughout the Central Valley can not be accomplished by a single entity. Partnerships among the public, interest groups, and agencies are needed to make substantial improvements in fish production. Partnerships, voluntary collaborations among entities to achieve mutual goals and objectives, are desirable because they accelerate accomplishments, increase available resources (i.e., partners can combine funding, staff, and expertise), reduce duplication of efforts, encourage innovative solutions, improve communication among entities, and increase public involvement and support (e.g., by sharing authority and ownership of restoration actions). The AFRP will seek partners to facilitate restoration whenever possible. Although partnerships may result in altering the manner or sequence that the AFRP alone would implement specific actions, the relative merits of progress over planning will be considered.

Local involvement

The AFRP will encourage local individuals and groups to assume a lead role in implementing restoration actions. Factors influencing anadromous fish production in specific watersheds are often related to local water management and land use. These factors are typically controlled by individuals and local groups that have close economic and social ties with the aquatic resources. Restoration will benefit from local involvement because local people may have insight into innovative approaches to solving problems and can most efficiently implement those solutions. This approach is consistent with the approach endorsed by twenty-six state and federal agencies in "California's Coordinated Regional Strategy to Conserve Biological Diversity" (MOU 1991); wherein these agencies emphasize regional solutions to regional issues and needs.

The AFRP will encourage local involvement by supporting the formation of local conservancies to implement restoration actions. This approach may proceed through existing groups, or groups may form to participate in restoration.

Public support

Public support is a product of partnerships and local involvement. Public sentiment is a strong and real indicator of perceived economic and social effects and a true measure of reasonableness for specific restoration actions. Public support for an action will facilitate implementation and attract partners for future actions. The AFRP will seek opportunities for the public to express their ideas and concerns to assist in implementing restoration actions.

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Adaptive management

The AFRP will employ adaptive management to increase the effectiveness of restoration actions and to address scientific uncertainty. Adaptive management is an approach that allows resource managers to learn from past experiences so that, if necessary, they may alter management actions implemented in the future. This approach may range from conducting a formal experiment to altering actions based on evaluations of their past performances.

Flexibility

Implementation of restoration actions needs to be flexible so that unforseen opportunities can be pursued if they meet the intent of the CVPIA. For example, the AFRP could take advantage of an opportunity to purchase land from a willing seller if the purchase satisfies a long-term objective, even though the action was not in this plan or considered a low priority.

IMPLEMENTATION PROCESS

The USFWS and USBR believe that implementing actions through partnership will be the most effective means for success. Partnership development will take time and is a process that in our view should occur in the local watershed with all the interested and involved parties working together. There are several examples of local watershed partnerships successfully operating in the Central Valley, including the Mill Creek and Deer Creek conservancies. Guidelines for the formation of local resource conservation partnerships is contained in the "California Coordinated Resource Management and Planning Handbook" (CCRMP 1990).

If the local partnership needs CVPIA resources to implement habitat restoration actions consistent with the AFRP, then a request should be forwarded to the Program Manager of the USFWS's Central Valley Fish and Wildlife Restoration Program (CVFWRP). USFWS and USBR anticipate following the implementation process discussed below.

SOURCES OF ACTIONS

Actions considered for implementation can come from a number of sources. For example, actions can come from the AFRP Working Paper, from actions recommended to the USFWS in responses to a request published in the Working Paper, from actions listed in the CDFG's documents titled "Restoring Central Valley Streams: A Plan for Action" Reynolds et al. 1993) and subsequent "Status of Implementation" report (Mills 1995), and from Category III of the CALFED Program's list of actions (found on the World Wide Web at http://www.delta.dfg.ca.gov/data/category3/cat3home.html). In addition,

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the DOI will continue to consider action recommendations it receives, as well as soliciting action recommendations to address specific problems. Recommendations should be submitted to the Program Manager of the CVFWRP. To the extent possible, recommended actions should be submitted in a format similar to that used to describe actions in this Restoration Plan (see Appendix A).

SELECTING ACTIONS

For any action to be sponsored by the AFRP, that action must contribute to doubling natural production of anadromous fish, and must be consistent with the provisions and intent of the CVPIA, as they appear in the CVPIA and in the current draft of the AFRP Position Paper (Appendix C). Chief among these provisions is that the AFRP "makes all reasonable efforts" to double natural production. The following section describes a process and criteria to determine reasonable efforts.

Process and criteria to determine reasonable actions -The phrase "reasonable efforts" has been widely interpreted to mean actions that will not result in unreasonable costs or impacts to individuals, interest groups or society at large. In addition to impacts, what is reasonable depends upon the magnitude of benefits, the certainty that an action will achieve the projected benefits and the authority established by existing laws and regulations.

This section describes a process and presents some general evaluation criteria to be used in identifying reasonable restoration actions (Figure 1). We believe that this will assist program participants in identifying actions that can be implemented to make progress toward doubling natural production of anadromous fish. This process is not meant to replace National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA)processes or to circumvent existing laws and regulations for those actions to which they apply. Many actions considered reasonable by criteria in Figure 1 may be subject to NEPA or CEQA processes.

Explanation of Figure 1:

1) Proposed actions must contribute to doubling natural production of anadromous fish, and must be consistent with the provisions and intent of the CVPIA. The basis for how this criterion will be applied is described within the CVPIA, and within the current draft of the AFRP Position Paper (Appendix C).

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2) Review of scientific and technical information should be separated from consideration of economic and social impacts in evaluating projects. AFRP participants should develop and adopt objective criteria that can be used to determine whether the existing information is adequate to proceed with further evaluation and implementation.

3) Reasonable actions must comply with existing laws and regulations. This is established in Section 3406(b), which directs the Secretary of the Interior to "...operate the CVP to meet all obligations under state and federal law...". Restoration actions that address limiting factors that are not related to the CVP will be expected to adhere to this same standard.

4) Actions that are implemented under the authority of existing environmental laws will be considered reasonable. Existing laws were enacted by elected representatives and should reflect what society as a whole currently believes is reasonable; existing regulations are assumed to have been developed with the benefit of public review and comment. Within the constraints of a specific law or regulation, it

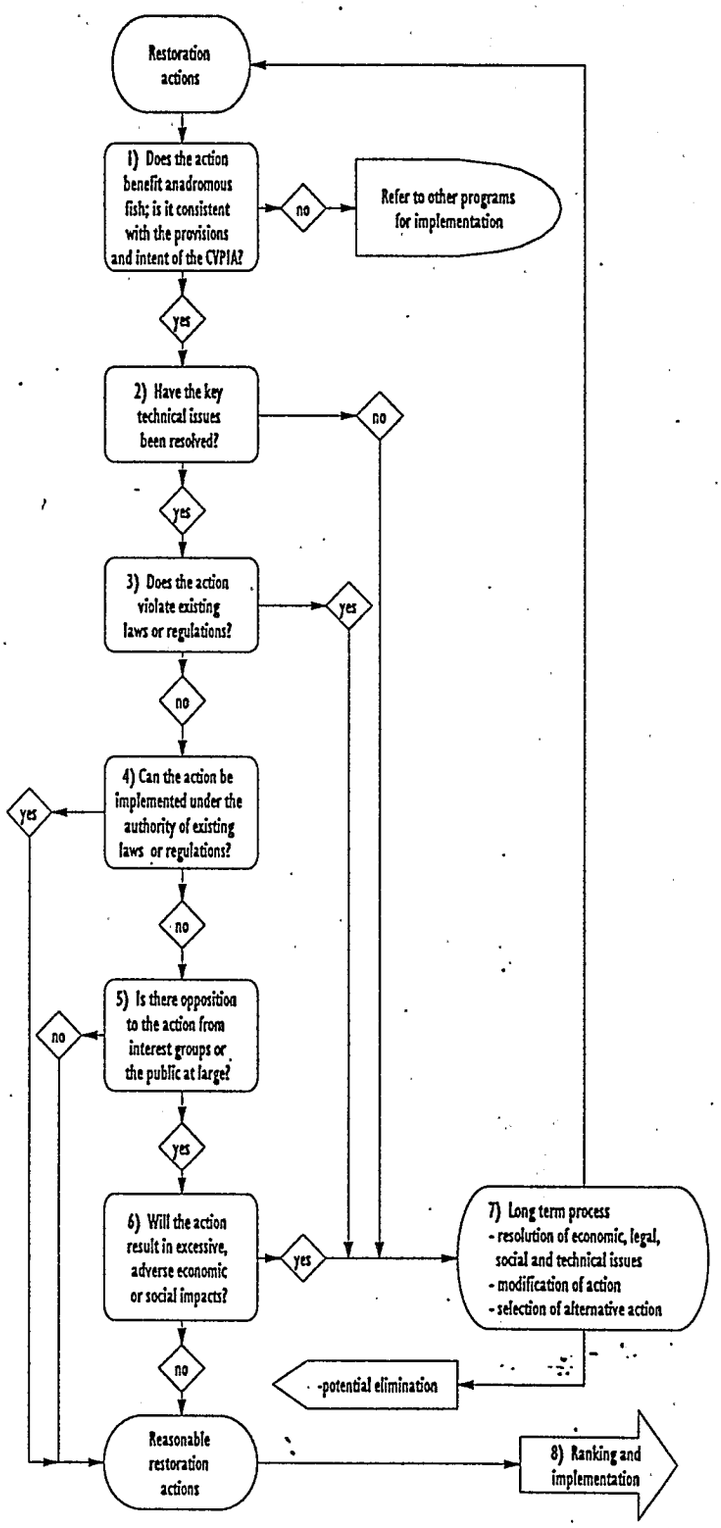

Figure 1. Process and criteria to identify reasonable restoration actions for implementation under the Anadromous Fish Restoration Program (see explanation in text).

may still be necessary excercise discretionary flexibility to ensure that implementation occurs in a reasonable manner.

5) Actions that are not opposed by individuals, interest groups or the public at large will be considered reasonable. Lack of strong opposition probably indicates impacts will be minimal. Opposition will be gaged through public meetings, letters received, and, where available, through NEPA or CEQA processes.

6) Actions that do not result in excessive economic or social impacts will be considered reasonable. Economic and social impacts should be verifiable and should be determined by standard methods that are agreed to in advance by all participants. Methods established for application under the NEPA and CEQA processes may be useful for this purpose.

7) Actions that are not identified as reasonable will be deferred for future consideration. Ultimately, these actions could be modified and reevaluated, replaced with alternate actions that have similar benefits, or eliminated from further consideration. In some cases actions may become reasonable as a result of changing social and economic factors. Alternate or revised actions will be subjected to the same reasonableness screening process as the original actions.

8) Actions identified as reasonable will be prioritized and implemented, contingent upon availability of funding and other resources.

Criteria to prioritize reasonable actions

Because resources are not sufficient to implement all reasonable actions simultaneously, an attempt will be made to implement high-priority items first. Monitoring the success of implemented actions will provide information that will help reevaluate priorities for remaining actions. However, the implementation schedule should be flexible to allow the AFRP to take advantage of unique opportunities to implement actions, even if those opportunities result in implementing actions that are not the highest priority.

Prioritization criteria primarily include biological considerations. The biological considerations are derived from the implementation principles described in the strategies section of this plan, whereas the non-biological considerations concern authority of the USFWS or USBR to implement restoration actions. In the following sections, species are prioritized first, then watersheds are prioritized, and finally criteria to prioritize types of actions within each watershed are listed.

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Species priority

Species and races are prioritized based on their status Species and races of special concern received higher priority than others. In descending order of importance, these are winter-run chinook salmon, spring-run chinook salmon, steelhead, late fall-run chinook salmon, fall-run chinook salmon in the San Joaquin River, green sturgeon, and fall-run chinook salmon in the Sacramento River and Delta tributaries.

Emphasizing restoration of species of special status will benefit other species.

Watershed priority

Watersheds are prioritized based on a combination of biological and non-biological factors. Biological factors include the presence of species and races of anadromous fish with special status and the production capacity within each watershed.

Watersheds that support, or have the potential to support species or races of special status are assigned priority over those watersheds that do not.

Watersheds with a high capacity to increase fish production, relative to production during the baseline period, are assigned priority over those watersheds with a lower capacity to increase production. Thus, higher priority is generally placed on watersheds with severely degraded habitat than those with less severely degraded habitat.

A non-biological consideration is the Secretaries' ability to facilitate restoration. Because the CVPIA directs the AFRP to address effects of the CVP on anadromous fish and habitat; and provides more tools to the USFWS and USBR to implement restoration actions for such streams and facilities than elsewhere; streams with CVP facilities or flows controlled primarily by the CVP are considered high priority.

The highest priority for restoration is assigned to the Sacramento-San Joaquin Delta because all anadromous fish in the Central Valley must pass through it as both juveniles and adults. The second higest priority is assigned to the upper Sacramento River because it provides habitat for endangered winter-run chinook salmon, is the primary area for production of other species and races, and is strongly influence by operation of the CVP. The third highest priority is assigned to the following tributaries of the upper Sacramento River: Clear, Battle, Butte, Deer, and Mill creeks. These streams have high potential for production of spring-run chinook salmon and steelhead. Fourth highest priority is assigned to the tributaries of the San Joaquin River because fall-run chinook salmon there may be distinct from fall-run in the Sacramento River, production of San Joaquin fall-run chinook salmon periodically fall to very low levels, and the tributaries are highly degraded. Information used to prioritize watersheds are summarized in Appendix D.

Action priority

Criteria to prioritize actions within a watershed involve determining primary limiting factors, i.e., "bottlenecks", to fish production. Limiting factors have been identified in the Working Paper (USFWS 1995) and through substantial comments and data supplied by various groups. Limiting factors were considered in the context of their relative importance in inhibiting fish production, and if alleviated, the potential that other limiting factors would be ameliorated. In general, actions that promote natural channel and riparian habitat values and natural processes (e.g., those affecting stream flow, water temperature, water quality, and riparian areas) score high. Actions affecting access to streams or determents to emigration (e.g., migration barriers and sites of entrainment into diversions) score medium, whereas actions that do not directly affect habitat (e.g., hatchery practices, harvest regulations, and law enforcement) score low. Depending on the watershed, factors associated with fish access to habitat rather than habitat quality may be identified as the primary limiting factors. In these instances, actions relating to fish passage may be assigned high priority.

IMPLEMENTING ACTIONS

Tools for implementing actions

Tools in the CVPIA--The tools available to the Secretary for achieving the goals of the AFRP include implementing all sections of the CVPIA. Sections 3406(b)(2) through (21) of the CVPIA authorize and direct the Secretary, in consultation with other state and federal agencies, Indian tribes, and affected interests, to take specific actions. These actions are briefly described below. Further details are provided in the CVPIA.

3406(b)(1)(B) - Modify CVP operations.

3406(b)(2) - Manage 800,000 af of CVP yield for fish, wildlife, and habitat restoration purposes.

3406(b)(3) - Acquire water to supplement the quantity of water dedicated for fish and wildlife water needs under (b)(2), including modifications of CVP operations; water banking; conservation; transfers; conjunctive use; and temporary and permanent land fallowing, including purchase, lease, and option of water, water rights, and associated agricultural land.

3406(b)(4) - Mitigate for Tracy Pumping Plant operations.

3406(b)(5) - Mitigate for Contra Costa Canal Pumping Plant operations.

3406(b)(6) - Install temperature control device at Shasta Dam.

3406(b)(7) - Meet flow standards that apply to CVP.

3406(b)(8) - Use pulse flows to increase migratory fish survival.

3406(b)(9) - Eliminate fish losses due to flow fluctuations of CVP.

3406(b)(10) - Minimize fish passage problems at Red Bluff Diversion Dam.

3406(b)(11) - Implement Coleman National Fish Hatchery Plan and modify Keswick Dam Fish Trap.

3406(b)(12) - Provide increased flows and improve fish passage and restore habitat in Clear Creek.

3406(b)(13) - Replenish spawning gravel and restore riparian habitat below Shasta, Folsom, and New Melones Reservoirs.

3406(b)(14) - Install new control structures at Delta Cross Channel and Georgiana Slough.

3406(b)(15) - Constuct, in cooperation with the State and in consultation with local interests, a seasonally operated barrier at head of Old River.

3406(b)(16) - In cooperation with independent entities and the State, monitor fish and wildlife resources in the Central Valley.

3406(b)(17) - Resolve fish passage and stranding problems at Anderson-Cottonwood Irrigation District Diversion Dam.

3406(b)(18) - If requested by the State, assist efforts to restore the striped bass fishery in Bay-Delta.

3406(b)(19) - Reevaluate carryover storage criteria.

3406(b)(20) - Participate with the State and other federal agencies in the implementation of the on-going program to mitigate for the Glenn-Colusa Irrigation District's Hamilton City Pumping Plant.

3406(b)(21) - Assist the State in efforts to avoid losses of juvenile anadromous fish resulting from unscreened or inadequately screened diversions.

In addition to these actions, Section 3406(e)(1 through 6) directs the Secretary to investigate and provide recommendations on the feasibility, cost, and desirability of implementing the actions listed below. Further details are provided in the CVPIA.

3406(e)(1) - Measures to maintain suitable temperatures for anadromous fish survival by controlling or relocating the discharge of irrigation return flows and sewage effluent, and by restoring riparian forests.

3406(e)(2) - Opportunities for additional hatchery production to mitigate the impacts of water development and operations on, or enhance efforts to increase Central Valley fisheries; Provided, That additional hatchery production shall only be used to supplement or to re-establish natural production while avoiding adverse effects on remaining wild stocks.

3406(e)(3) - Measures to eliminate barriers to upstream and downstream migration of salmonids.

3406(e)(4) - Installation and operation of temperature control devices at Trinity Dam and Reservoir.

3406(e)(5) - Measures to assist in the successful migration of anadromous fish at the Delta Cross Channel and Georgiana Slough.

3406(e)(6) - Other measures to protect, restore, and enhance natural production of salmon and steelhead in tributary streams of the Sacramento and San Joaquin Rivers.

Finally, section 3406(g) of the CVPIA directs the Secretary to develop models and data to evaluate the ecologic and hydrologic effects of existing and alternate operations of public and private water facilities and systems to improve scientific understanding and enable the Secretary to fulfill requirements of the CVPIA.

The CVPIA establishes the "Central Valley Project Restoration Fund" and gives the Secretary the authority to use the fund "...to carry out the habitat restoration, improvement and acquisition (from willing sellers) provisions..." of the CVPIA (Section 3407), including the actions listed above. Funding priorities for use of the Restoration Fund are being developed and will be described in a report to Congress in early 1996 pursuant to sections 3407(a) and (f) of the CVPIA.

D-021961

Restoration actions using the tools listed above will be implemented by the USFWS and USBR to contribute to doubling production of anadromous fishes. Each of these tools is being managed separately under the coordination of the Program Manager for the CVFWRP. Managers of these subsections will use this plan as a guide to help establish priorities and identify actions. Specific actions for each program will be selected according to the overall strategies stated in the Introduction to this Restoration Plan. These managers will ensure that actions conducted pursuant to the CVPIA will be further coordinated and complementary to ongoing restoration actions of other groups in the Central Valley and Bay-Delta (e.g., CDFG, Category III of the CALFED Bay-Delta Program, and mitigation agreements of the CDWR).

Actions not directly addressed by tools in the CVPIA will be managed by the Program Manager for the AFRP. These actions will be dependent on partnership with other agencies, especially the CDFG, for implementation.

Several tools listed above may contribute to goals other than to increase the natural production of anadromous fish. For example, 3406(b)(18) and (e)(2) may include artificial production, or other contributions to total production, such as pen rearing of salvaged striped bass, that would not directly contribute to natural production (see the AFRP Position Paper in Appendix C for definition of natural production). In fact, some fishery interests believe that artificial production is needed to supplement reasonable habitat restoration actions to stabilize or increase total production of fall-run chinook salmon in the San Joaquin tributaries and striped bass. While the AFRP can not directly support artificial production and pen rearing, it is the intent of the AFRP to coordinate its efforts with these and similar efforts conducted under other subsections of the CVPIA to achieve the greatest benefit for fish and wildlife that the CVPIA can provide.

Tools limited to use on CVP-controlled streams - Tools available to the Secretary to implement actions on streams where flows are controlled primarily by CVP structures are greater than the tools available on streams where flows are not controlled by CVP structures. For example, modification of CVP operations (Section 3406(b)(1)(B)) and use of the 800,000 acre-feet (Section 3406(b)(2)) are limited to CVP-controlled streams. The CVP-controlled streams include the Sacramento, American, Stanislaus, and San Joaquin rivers (although restoration of anadromous fish habitat on the San Joaquin River is limited to that section downstream of Mendota Pool) and Clear Creek. In addition, the CVP controls exports at the Tracy Pumping Plant.

To date a process for the long-term management of the 800,000 acre-feet (AF)of CVP yield dedicated for fish and wildlife and habitat restoration by Section 3406(b)(2) of the CVPIA has not been developed. However, draft interim guidelines are currently being reviewed by the public and comments solicited by the DOI. During 1993-1995, the approach contained in the "White Paper" (December 1994 letter of agreement between

D-021962

the USFWS and USBR) was used, wherein the USFWS submitted annual habitat and flow objectives to the USBR for implementation in the Sacramento, American, and Stanislaus rivers, and the Delta. These objectives were developed annually in coordination with CDFG and USBR and considered the projected hydrologic conditions. USBR used the following management strategies pursuant to CVPIA to meet the habitat and flow objectives; modification of project operations; management of the 800,000 AF of CVP yield; acquisition of water for fish and wildlife purposes; and use of water from other sources which do not conflict with fulfillment of the Secretary's contractual obligations to provide CVP water for other authorized purposes (Section 3406(b) paragraphs (1)(B) and (3)). The DOI used a portion of the dedicated water to help meet objectives for Delta outflow, cross channel gate closure, and export curtailment in the Delta. The draft interim guidelines will be revised, after receiving comments, and become the guidelines for management of the 800,000 AF of CVP yield to help meet the habitat and flow objectives for anadromous fish. Proposed rules and regulations for the management of the dedicated yield as part of a long-term planning process will be drafted and made available for public review and comment in 1996.

Cooperation with others--In most streams of the Central Valley, the Secretary does not have direct authority to implement restoration of anadromous fish production because flows are not controlled by CVP facilities. Non-CVP controlled streams include Battle, Mill, Deer, Butte, Elder, and Thomes creeks and Feather, Yuba, Bear, Cosumnes, Mokelumne, Calaveras, Tuolumne and Merced rivers, as well as most of the Delta. Private land owners, public and private irrigation districts, utilities, the State Water Project, and municipalities and industry manage facilities and flows on these streams. To assist in restoration of these streams, as directed by the CVPIA, the Secretary will require the cooperation of other entities. Cooperation through partnerships of the USFWS and USBR with other entities, which have the authority, interests, or resources to facilitate restoration, will provide a tool to implement actions in this restoration plan.

The USFWS and USBR encourage potential partners to come forward and enter into voluntary relationships with the agencies to conduct restoration actions. Other entitites may include local watershed agencies and groups, state agencies, and other federal agencies.

The USFWS and USBR have several mechanisms under which they can formally establish cooperative relationships with individuals, watershed groups, and conserveration groups, and with local, state and other federal agencies. These mechanisms are discussed in "Conservation Partnerships: A Field Guide to Public-Private Partnering for Natural Resource Conservation" (MIEB 1993). Selection of the the appropriate mechanism will depend on the role of the USFWS or USBR in relation to the partners. A guideline for selecting mechanisms is shown in Figure 2. Each of these mechanisms is briefly explained below:

D-021963

- Interagency agreements--used when one agency is providing payments, goods or services to another agency. For federal agencies, the Economy Act allows for this if an efficiency gain can be realized.

- Procurement arrangements--used when an agency pays to receive a direct benefit. It is treated as a procurement action.

- Memoranda of understanding--most commonly used to establish partnerships and document specific responsibilities; signatories agree to work toward mutual goals, perform joint work, or share research results, but no obligation of funds may be included.

- Grants--allow the USFWS and USBR to transfer money, property, services or anything of value to an outside group for a project of mutual interest where substantial agency involvement is not anticipated.

- Cooperative agreements --allow the USFWS and USBR transfer money, property, services or anything of value to an outside group for a project of mutual interest where substantial agency involvement is anticipated.

- Challenge cost-sharing--allow the USFWS and USBR and other federal agencies to receive funds and requires recipients to match this money with non-federal funds, labor, materials, equipment or land and water, typically of one-to-one.

Through these mechanisms, the USFWS and USBR can make agreements and direct funds or services to partners. The partners could then undertake the responsibility to

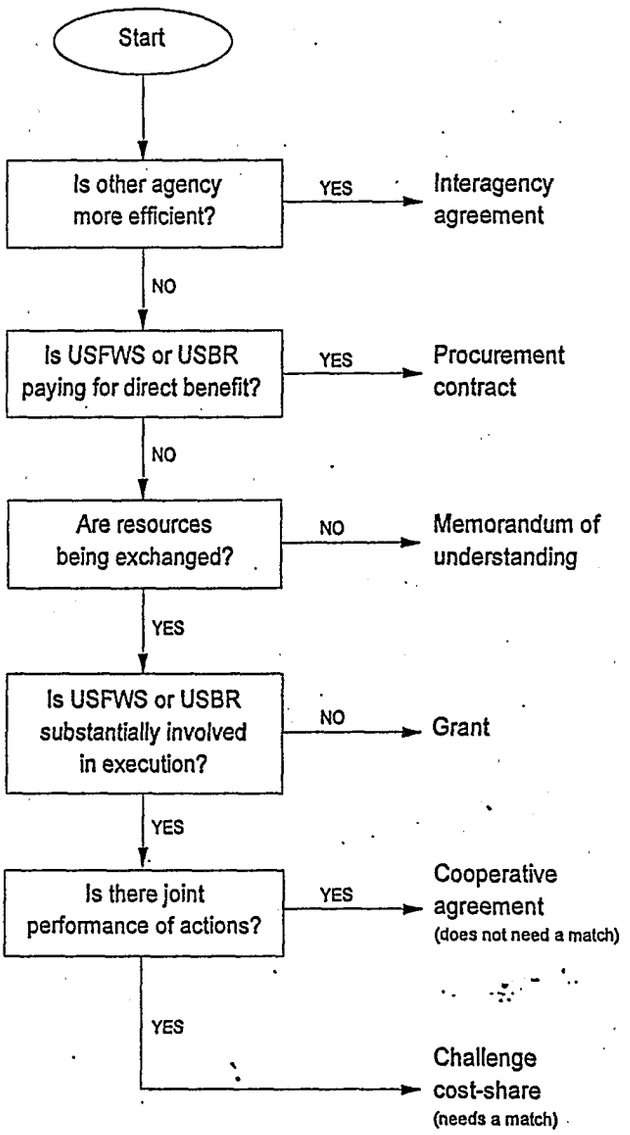

Figure 2. Mechanisms for working together (adapted from MIEB 1993).

D-021964

implement specific restoration actions. The CVPIA [Section 3407(e)] provides the Secretary with the flexibility to use several of the mechanisms for working together to fund non-federal partners by stating:

> "If the Secretary determines that the State of California or an agency or subdivision thereof, and Indian tribe, or a non-profit entity concerned with restoration, protection, or enhancement of fish, wildlife, habitat, or environmental values is able to assist in implementing any action authorized by this title in an efficient, timely, and cost effective manner, the Secretary is authorized to provide funding to such entity on such terms and conditions as he deems necessary to assist in implementing the identified action."

Funds dispersed through this section are subject to cost-share requirements contained in other sections of the CVPIA. Potential partners and possible mechanisms for working together are:

Local agencies and groups--Watershed conservancies, conservation groups, water districts, non-profit groups, and individual property owners can assist in implementation of restoration actions of the AFRP. Agreements with or funds and services can be directed to these groups through memoranda of understanding, grants, cooperative agreements, and challenge cost-sharing. In areas where there is local support but a conservancy group does not exist, the USFWS and USBR may provide funds to facilitate the formation of a local watershed conservancy. Information on the formation and support of local watershed conservation groups is contained in the "California Coordinated Resource Management and Planning Handbook" (CCRMP 1990) In addition, the USFWS and USBR is developing a grant program entitled "Project Double" which is designed to allow small groups to participate in restoration actions.

State agencies--The CDFG, CDWR, Reclamation Board, SWRCB, and other state agencies have expertise, abilities, experience, and a willingness to assist in the implementation of many actions of the AFRP. To accomplish development and implementation of actions through state agencies, the USFWS and USBR can enter into procurement arrangements, memoranda of understanding, grants, and cooperative agreements.

Other federal agencies--The Natural Resources Conservation Service, U.S. Forest Service, Bureau of Land Management, NMFS, U.S. Geologic Survey, National Biological Service, U.S. Army Corps of Engineers, and other federal agencies likely have specific expertise, abilities, and a willingness to assist in implementation of specific actions.

D-021965

Through interagency agreements, procurement arrangements, and challenge cost-sharing, the USFWS and USBR can enter into agreements with other federal agencies to provide funding or services for development, review and implementation of restoration actions.

MONITORING AND EVALUATION

Monitoring, using standardized and validated methods, is essential to obtain data on anadromous fish production and associated habitats to facilitate an evaluation of the effects of restoration actions conducted by the AFRP, its partners, and related programs. When possible, data collection should begin before specific restoration actions are implemented so that an adequate pre-treatment baseline is established. Post-treatment data collected after implementation of actions could then be compared to the pre-treatment baseline. These data are essential for evaluating the contribution of actions to doubling natural production.

Most data used to establish the AFRP doubling targets for production of anadromous fish from the baseline period 1967-1991 were derived from sampling programs conducted by the CDFG (Mills and Fisher 1994). These programs consisted primarily of carcass counts, angler surveys, and ocean harvest records of salmonids; adult and juvenile population estimates and angler surveys of striped bass; an index of juvenile abundance of American shad; and adult population estimates of both white sturgeon and green sturgeon. Although these data were derived from programs designed for purposes unrelated to the goal of the AFRP, the data they generated represent the most complete data set pertinent to anadromous fish in most Central Valley streams and the Bay-Delta. The AFRP recommends that these programs continue, and suggests that efforts be made to refine methods and integrate monitoring conducted by the CDFG with that needed by the AFRP. This would reduce duplication of efforts and effectively allocate total funding by both entities for monitoring throughout the Central Valley.

Monitoring by the AFRP and CDFG should also be integrated with other existing programs such as the Interagency Ecological Program (IEP) and others initiated to comply with mitigation requirements for specific projects. An oversight committee or forum should be used to coordinate activities of all entities involved in monitoring related to anadromous fish and their habitats in the Central Valley and Bay-Delta. An oversight group could also ensure that efforts are complementary, encourage an open exchange of information, and establish a repository or clearinghouse for data. An additional function of such a group would be to assist in directing future monitoring activities by identifying deficiencies in the current data base for species or life history stages for which little information is available or locations where inadequate information exists on the production, abundance, and distribution of anadromous fish.

D-021966

The IEP has been suggested as an appropriate entity for coordinating monitoring in the Bay-Delta and for managing all data. A subgroup of IEP, which would include experts in various watersheds, should be established to provide oversight for Central Valley streams.

A diverse array of data will be required to fully evaluate restoration actions in the Central Valley and the Bay-Delta. To anticipate potential data needs, the AFRP proposes a hierarchical approach to monitoring, from fine to coarse spatial and temporal scales (e.g., action-specific, watershed-specific, and system-wide scales, and short- versus long-term temporal scales). Conclusions facilitated by monitoring at all scales should be used so that restoration can be adaptively modified and refined.

Action-specific

Monitoring the effects of specific restoration actions should facilitate evaluation at the finest spatial, and possibly temporal, resolution. This could be a short-term process, intended to determine the immediate effectiveness of restoration actions (e.g., is a particular screen preventing entrainment of juvenile fish, is vegetation becoming established on a restored streambank, or has an operational modification resulted in the desired change in stream flow and water temperature). The results of action-specific evaluations will contribute to an evaluation of the overall success of Section 3406(b) of the CVPIA (described below).

It is the policy of the USFWS and USBR that restoration actions implemented pursuant to Section 3406(b) of the CVPIA will include a plan to assess the effectiveness of each action. Ensuring that each action includes monitoring will be the responsibility of the AFRP, designated agencies, and partners.

Watershed-specific

The purpose of monitoring at this scale should be to evaluate the cumulative effects of all restoration actions within a single watershed, beginning by providing a baseline before actions are implemented and a review of existing data. Data collected specifically for a watershed may span a relatively short or long period, but address the overall results of multiple actions (e.g., is there an improvement in the abundance, timing, and distribution of juvenile anadromous fish or have selected habitat variables changed). The primary monitoring objective of the AFRP will be to use indices of juvenile life history stages and estimates of adult production of anadromous fish in evaluating the effectiveness of restoration actions in specific watersheds. The results of watershed-specific evaluations will also contribute to an evaluation of the overall success of Section 3406(b) of the CVPIA (described below).

System-wide and long-term

At the most coarse scales, the long-term effects of restoration actions should be assessed throughout the Central Valley and Bay-Delta. For example, the primary biological measure may be production of adult fish, but could also include measures of abundance at adult or juvenile life stages. Long-term production of adult fish should be monitored in all watersheds the AFRP and affiliated entities attempt to restore.

System-wide monitoring efforts should include hatchery produced fish, primarily chinook salmon and steelhead. The AFRP encourages that either all or a constant fraction of hatchery salmonids released from Central Valley hatcheries be uniquely marked according to their site of origin, release site, and release date. This would not only allow managers to differentiate between wild and hatchery fish spawning in streams, but clarify the distribution of hatchery fish in the system, determine their relative contribution to commercial and sport harvest, and assist in evaluating factors affecting fish survival. Specific studies should be designed to investigate how hatchery fish interact with naturally produced fish so that the effects of hatchery practices on the population genetics and dynamics of naturally produced fish can be evaluated.

To determine the effects of restoration actions on improving fish and riparian habitat values, other components of the Central Valley ecosystem should be monitored. These include determining long-term changes in characteristics of stream channels, riparian areas, and water quality. Additional sampling of fish assemblages could be incorporated into sampling protocols, and the resulting data used to evaluate fish community responses to restoration actions through time.

Section 3406(b)(16) of the CVPIA has been established with the objective to evaluate the cumulative effects of efforts to restore fish production and aquatic habitat. This section directs the Secretary to "establish in cooperation with independent entities and the State of California, a comprehensive assessment program to monitor fish and wildlife resources in the Central Valley to assess the biological results and effectiveness of actions implemented pursuant to this subsection." The Comprehensive Assessment and Monitoring Program (CAMP) was initiated pursuant to Section 3406(b)(16), and will assist in directing future monitoring activities. A draft conceptual plan prepared for CAMP uses a watershed-specific approach for evaluating long-term trends in anadromous fish. Therefore, CAMP will not address action- or site-specific monitoring. It will rely on information from other monitoring programs established under the AFRP and other programs to provide the basis for the evaluation of the overall success of actions taken under Section 3406(b) of the CVPIA. Because the AFRP restoration targets are based on natural production of adult anadromous fish, CAMP will emphasize this attribute in selected watersheds. However, measures of hatchery production and harvest will be

D-021968

needed to facilitate determining success toward doubling natural production of anadromous fish.

DEALING WITH SCIENTIFIC UNCERTAINTY

Resource management decisions are frequently made with varying degrees of scientific uncertainty. Primary factors contributing to uncertainty are the variability of biological processes and the physical conditions on which they depend. Moreover, the large geographic range and long life-span of anadromous fish restrict the ability of resource managers to employ many control and replicate groups in studies, as is common in other fields of science (Hilborn and Ludwig 1993). A result is that sufficient data to describe processes, evaluate important variables, and predict results of management actions with a high degree of certainty are often impossible to attain. Thus, analyses are subject to multiple interpretations, and management decisions must rely on the best available data and professional judgement.

By acknowledging scientific uncertainty in making decisions, resource managers engage in risk assessment. From the perspective of the resource, managers must balance the certainty of a predicted effect of a management action with the need to act. An extreme example is the certainty of effects resulting from implementing the recovery plan for winter-run chinook salmon in the Sacramento River (NMFS 1993) compared with the probable results of not implementing the recovery plan, continued decline and likely extinction of the race. However, managers must also consider the human dimension as part of the system in making decisions (Ludwig et al. 1993). That is, they must assess the relation between human activities and the resource, such as potential economic and social effects of management actions.

A responsive approach to address scientific uncertainty about the effects of restoration actions is to employ adaptive management. This approach can be separated into three phases. First, initial actions, based on any data available and professional judgement, would be implemented, especially to protect anadromous fish populations that are in immediate danger of extinction or undergoing drastic decline. Second, the effects of initial actions would be monitored to evaluate their effectiveness. Third, actions would be modified, if necessary, to improve their benefits.

Actions in the AFRP restoration plan are intended to fit the first phase of adaptive management. To address the second phase, a policy of the USFWS and USBR is that every action in the restoration plan requires monitoring to assess it's effectiveness. Although monitoring is intended to facilitate an evaluation of an action's effectiveness, an additional benefit is to reduce the uncertainty of an action's effects on anadromous fish and their habitats. In addition, many actions supported by the AFRP are actually evaluations. The purpose of evaluations are to further investigate potential problems

D-021969

affecting anadromous fish and to provide insight into restoration opportunities by reducing scientific uncertainty. The third phase, modification and revision of actions, will be attempted through annual evaluations and continued interaction with interest groups.

Evaluations are important for contested issues, especially where uncertainty surrounding an issue prevents progress toward restoration. The AFRP will encourage parties involved in such issues to agree in advance to take specific actions contingent upon the results of evaluations. Otherwise, in the absence of agreements, conducting evaluations will neither decrease scientific uncertainty nor effectively contribute to restoration.

The levels of certainty used in the development of the restoration plan are, in the view of the AFRP, reasonable to support the recommended actions. Considering the status of listed and potentially listed species and races of anadromous fish and the substantial declines in others, there is a real urgency for action to reverse these trends. In addition, delays to restore some anadromous fish stocks may ultimately reduce future management options.

The USFWS and USBR will continue to use the best available scientific information in making and effecting management decisions. We must also acknowledge that in the biological sciences and in managing natural ecosystems, uncertainty is often substantial and cannot be eliminated. With imprecise and incomplete information being inherent in the science, professional judgement will continue to be employed to make the best possible recommendations.

PUBLIC INVOLVEMENT

Introduction

Section 3406(b)(1) of the Central Valley Project Improvement Act presents two great challenges for implementation. First, Congress left it up to DOI to determine actions that are reasonable to implement. Second, DOI's authority to implement actions is limited. This limitation emphasizes the role of voluntary partnerships in effecting restoration actions to double natural production throughout the Central Valley. Even for actions that the DOI is authorized to take, partnerships in implementation are important if they are to be performed efficiently and without wasteful dispute. As discussed in the Introduction and Implementation Process sections of this plan, public support and local involvement are integral parts of the plan's strategies and implementation.

The USFWS and USBR are committed to involving the affected and interested publics in planning and implementing restoration actions to the maximum extent practicable to accomplish the goal.

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Approach

There are two levels of public involvement for the AFRP. The first level is programmatic in nature and involves planning a comprehensive program. The affected and interested publics for this level are broad and include all areas of the Central Valley. The second level is action-specific in nature and involves the implemention of specific actions. The affected and interested publics for this level are localized and include specific watersheds.

Programmatic public involvement activities to date

CVPIA signed by President Bush	October 1992
Draft Plan of Action for the Central Valley Anadromous Fish Restoration Program released.	August 1993
Coalition of senior fish experts from the USFWS, USBR, NMFS, USEPA, CDFG, and CDWR formed the Core Group to direct the development of the AFRP.	October 1993
Public workshops held in Oakland, Fort Bragg, Sacramento, Fresno and Red Bluff to introduce the AFRP and to discuss the draft Plan of Action.	October-November 1993
Core Group formed eight AFRP technical teams consisting of experts from state and federal agencies, private industry and academia to develop actions deemed necessary to double natural production of anadromous fish populations.	March 1994
Final Plan of Action for the Central Valley Anadromous Fish Restoration Program released.	May 1994
Public workshop held in Sacramento to discuss the final Plan of Action.	May 1994
Draft Position Paper for Development of the Anadromous Fish Restoration Program released.	July 1994
Public workshop held in Sacramento to discuss the draft Position Paper.	July 1994

Central Valley Anadromous Sport Fish Annual Run-size, Harvest, and Population Estimates, 1967 through 1991, Third Draft, released by CDFG.	August 1994
Public workshop held in Stockton to discuss CDFG's Central Valley Anadromous Sport Fish Annual Run-size, Harvest, and Population Estimates.	October 1994
Working Paper on Restoration Needs released.	May 1995
Public workshops held in Oakland, Redding, Sacramento, Modesto, and Monterey to discuss the Working Paper on Restoration Needs; opportunity extended to public to comment orally or in writing on Working Paper.	June 1995
Draft Anadromous Fish Restoration Plan released.	November 1995

Future public involvement opportunities

Programmatic

Public review of the draft Anadromous Fish Restoration Plan.	December-January 1996
Public Workshops to receive comments on draft Anadromous Fish Restoration Plan	January 1996
Final Anadromous Fish Restoration Plan to be released.	Late winter 1996

Action-specific

Implementation of specific actions in the Anadromous Fish Restoration Plan (environmental documentation, permitting, and implementation partnerhips are important in this phase).	Ongoing

Public involvement mechanisms

Public participation is critical to successful development of the final plan. The following are public involvement mechanisms established to facilitate public input to the AFRP:

- Draft report review- Allows publics to contribute to report development.

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- Final reports- Document progress to a plan and offer publics a "road map" for implementation.

- Press releases- Announces significant events and the opportunity for involvement.

- Letters to interested parties- Provides information.

- Workshops and meetings- Offers an informal setting for public input and dialogue and learning to occur both for the AFRP and the attending publics.

- Educational materials- Provide summary or pertinent information about anadromous fish and the AFRP.

- Records of comments and responses- Summarize comments and AFRP responses.

- Environmental documentation- NEPA and CEQA compliance affords structured public involvement in scoping and review.

- Permitting- If required, regulatory permitting affords the public structured public involvement.

- Grapevine- Toll-free and automated information line at that provides information on meeting schedules, report releases, workshop announcements, etc. To reach this service, dial (800) 742-9474 or (916) 979-2330 and dial extension 542 after the recorded message begins.

- Internet home page- Provides up-to-date information on the AFRP and downloadable USFWS public release files. Our Internet address is:
  http://www.delta.dfg.ca.gov/usfws/fws_home.html

- Long-term monitoring and evaluation reports- Afford publics the opportunity to receive feedback on implementation, comment and carry this information into the long-term process.

- Mailing lists- Will be maintained and updated as requested.

- Action implementation partnerships- The implementation program for specific actions will seek to effect public involvement in the form of action-oriented partnerships, preferably local watershed workgroups. Actions that are beneficial and cost effective for the AFRP, as well as for the affected landowners, water-rights holders, local governments, and affected communities, should succeed.

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ACTIONS AND EVALUATIONS

The actions and evaluations included in this section originated from several sources, including the AFRP Working Paper, from public and private organizations and from individual contributors. They were subjected to the process to determine reasonable actions. Some of the actions from the Working Paper were determined to be unreasonable or in need of further evaluation, and were not included here. Some of these actions were replaced with more reasonable actions, others needed more evaluation and were modified into evaluations, rather than actions. With some actions, the language and intent were changed, perhaps reducing their potential biological benefit, to make them reasonable but still contribute to increasing natural production of anadromous fish. Others were combined where appropriate.

Actions and evaluations are categorized by stream or river. Streams are organized geographically, generally starting upstream and moving downstream, dealing with northern-most drainages first. Under each stream, actions and evaluations appear under separate subheaders, similar to the CDFG's Plan for Action (Reynolds et al. 1994). Evaluations are generally activities that will help define or contribute to actions for future implementation. As explained in the section of this plan titled "Monitoring and evaluation", the results of all actions will be monitored and evaluated. Evaluations should be viewed as part of the long-term process.

The actions and evaluations for each watershed are presented in separate tables consisting of four columns. The first column describes the action or evaluation in one or two brief sentences; the second lists the involved parties, including local watershed actions groups, public and private organizations and individuals expected to be involved in implementation; the third presents the CVPIA tools and mechanisms for working together among the USFWS and USBR and partners; and the last column lists the priority for the action or evaluation in relation to other actions or evaluations in the watershed.

In this draft of the restoration plan, the list of actions is presented as a laundry list of actions, without indicating priority or a schedule for implementation for individual actions. We expect to prioritize actions based on the ranking criteria in the November 9 to 17 period. During this time period, we also hope to further categorize the actions as those being implemented during the 1996 calendar year, those recommended for implementation within the next three to five years, and those to be implemented later.

A total of 212 actions and 70 evaluations are identified.

D-021974

SACRAMENTO RIVER BASIN

Upper mainstem Sacramento River

<table>
<tr><th>Action</th><th>Involved parties</th><th>Tools</th><th>Priority</th></tr>
<tr><td>1. Implement an overall river regulation plan that balances carryover storage needs with instream flow needs consistent with the Biological Opinion for winter-run chinook salmon (NMFS 1993) based on runoff and storage conditions, including the following table of minimum recommended flows at Keswick and Red Bluff Diversion Dams.

Recommended minimum Sacramento River flows (cfs) at Keswick Dam for October 1 to April 30 based on October 1 carryover storage in Shasta Reservoir and critically dry runoff conditions (driest decile runoff of 2.5 maf) to produce a target April 30 Shasta Reservoir storage of 3.0-3.2 maf for temperature control.

<table>
<tr><th>Carryover storage (maf)</th><th>Keswick release (cfs)</th></tr>
<tr><td>1.9 to 2.1</td><td>3,250</td></tr>
<tr><td>2.2</td><td>3,500</td></tr>
<tr><td>2.3</td><td>3,750</td></tr>
<tr><td>2.4</td><td>4,000</td></tr>
<tr><td>2.5</td><td>4,250</td></tr>
<tr><td>2.6</td><td>4,500</td></tr>
<tr><td>2.7</td><td>4,750</td></tr>
<tr><td>2.8</td><td>5,000</td></tr>
<tr><td>2.9</td><td>5,250</td></tr>
<tr><td>3</td><td>5,500</td></tr>
</table>
</td><td>USFWS, USBR, NMFS, CDFG</td><td>3406(b)(1)(B), 3406(b)(2), 3406(b)(3).</td><td></td></tr>
<tr><td>2. Implement a schedule for flow changes that avoids, to the extent controllable, dewatering redds and/or isolating or stranding juvenile anadromous salmonids, consistent with SWRCB Order 90-5.</td><td>USFWS, USBR, CDFG, SWRCB, NMFS</td><td>3406(b)(9)</td><td></td></tr>
</table>

Action	Involved parties	Tools	Priority
3. Continue to maintain water temperatures at or below 56°F from Keswick Dam to Bend Bridge to the extent controllable, consistent with the Biological Opinion for winter-run chinook salmon (NMFS 1993) and with SWRCB Order 90-5.	USFWS, USBR, CDFG, SWRCB, NMFS	3406(b)(1)(B), 3406(b)(6)	
4. Continue to raise RBDD gates at a minimum duration from September 15 to May 15 to protect primary adult and juvenile chinook salmon migrations, consistent with the Biological Opinion for winter-run chinook salmon (NMFS 1993) and with SWRCB Order 90-5, and accommodate water delivery using appropriate pumping facilities.	USFWS, USBR, SWRCB, NMFS, CDFG	3406(b)(10), 3406(b)(6)	
5. Construct escape channel from the Keswick Dam stilling basin to the Sacramento River as designed by NMFS and USBR, 1994.	USFWS, USBR, NMFS, CDFG	3406(b)(11)	
6. Continue implementation of the Anadromous Fish Screening Program.	USFWS, USBR, NMFS, CDFG	3406(b)(21)	
7. Implement structural and operational modifications at the Glenn-Colusa Irrigation District's (GCID) water diversion to minimize impingement and entrainment of juvenile salmon	GCID, USFWS, USBR, CDFG, NMFS	3406(b)(20)	
8. Remedy water quality problems and toxic discharge sources associated with Iron Mountain Mine and metal sludges in Keswick Reservoir, consistent with the ComprehensiveEnvironmental Response, Compensation, and Liability Act or "Superfund"and the Clean Water Act.	EPA, SWRCB USFWS, USBR, NMFS, CDFG .		

Action	Involved parties	Tools	Priority
9. Pursue opportunities to create a meander belt from Keswick Dam to Chico Landing to recruit gravel and large woody debris, to moderate air temperatures, enhance nutrient input.	Sacramento River Advisory Council (SRAC), CDFG, COE USFWS, USBR, CDWR, NMFS	3406(b)(13)	
10. Implement structural and operational modifications to Anderson-Cottonwood Irrigation District's (ACID) diversion dam to eliminate passage and stranding problems for chinook salmon and steelhead adults and early life stages, to eliminate toxic discharges from the canal and improve structural strength of fish screens.	ACID, USFWS, USBR, CDFG, RWQCB, NMFS	3406(b)(17)	
11. Develop and implement a program for restoring and replenishing spawning gravel, where appropriate, in the Sacramento River.	CDFG, USFWS, USBR, NMFS	3406(b)(13)	

Evaluation	Involved parties	Tools	Priority
1. Complete an integrated instream flow incremental methodology study (IFIM) to refine a river regulation program that actively balances fish habitat with the flow regime that considers adequate temperature, flushing flows, emigration, channel maintenance, attraction flows, and maintenance of a riparian corridor.	USFWS, USBR, CDFG, SWRCB, NMFS	3406(e)(1)	

Evaluation	Involved parties	Tools	Priority
2. Implement structural and operational modifications to Anderson-Cottonwood Irrigation District's (ACID) diversion dam to eliminate passage and stranding problems for chinook salmon and steelhead adults and early life stages, to eliminate toxic discharges from the canal and improve structural strength of fish screens.	ACID, USFWS, USBR, CDFG, RWQCB, NMFS	3406(b)(17)	
3. Evaluate oportunities to incorporate flows to restore riparian vegetation from Keswick Dam to Chico Landing with the overall river regulation plan.	USFWS, USBR, NMFS, CDFG, SRAC	3406(b)(1)(B), 3406(b)(13), 3406(e)(1)	
4. Complete the evaluation (EIR and EIS) to implement solutions to passage problems at RBDD, including measures to improve passage whenever the RBDD gates are closed.	USFWS, USBR, CDFG, TCCA, NMFS	3406(b)(10), 3406(e)(3)	
5. Evaluate placement of large woody debris and boulders in the upper Sacramento River and tributaries to permamently enhance salmonid rearing habitat.	CDFG, USFWS, USBR, CDFG, RWQCB, NMFS	3406(b)(1)	
6. Identify opportunities for restoring riparian forests in channelized sections of the Upper Mainstem Sacramento River consistent with flood control and other water management constraints.	SRAC, The Nature Conservancy (TNC), CDFG, COE, USFWS, USBR, CDWR, NMFS	3406(b)(13), 3406(e)(1)	

Evaluation	Involved parties	Tools	Priority
7. Identify and attempt to maintain adequate flows for white sturgeon and green sturgeon from February to May for spawning, migration, incubation and rearing in a manner that is consistent with actions implemented to meet recommendations for chinook salmon and steelhead.	USFWS, USBR, NMFS, CDFG	3406(b)(1)(B), 3406(b)(2), 3406(b)(3)	
8. Identify and attempt to maintain adequate flows from April to June for spawning, incubation, and rearing of American shad in a manner that is consistent with actions implemented to meet recommendations for chinook salmon and steelhead.	USFWS, USBR, NMFS, CDFG		
9. Identify and implement measures that will, to the extent controllable, maintain mean daily water temperatures (61°F and 65°F) adequate for American shad spawning between April 1 and June 30 that is consistent with actions implemented to meet recommendations for chinook salmon and steelhead.	USFWS, USBR, NMFS, CDFG	3406(b)(1)(B), 3406(b)(2), 3406(b)(3)	
10. Identify the extent of sturgeon entrainment at diversions and pumps and reduce or eliminate entrainment if found to be substantial	USFWS, USBR, CDFG, NMFS	3406(b)(21)	
11. Identify green sturgeon spawning sites and evaluate the availability and use by adult sturgeon.	USFWS, USBR, CDFG, NMFS		
12. Determine the effects of poaching and fishing on the number of spawning sturgeon.	USFWS, USBR, CDFG, NMFS		

Upper Sacramento River tributaries

Clear Creek

Action	Involved parties	Tools	Priority
1. Release 150 cfs October 1 to June 1 from Whiskeytown Dam for fall-run and late fall-run spawning and incubation (alongwith limited spring flushing flows) for temperature control, outmigration, gravel restoration and channel maintenance, provided that the total amount of release does not exceed the annual amount of water used by the CVP from the Clear Creek watershed.	CDFG, USFWS, USBR, SWRCB	3406(b)(8), 3406(b)(12)	
2. Attempt reestablishment of steelhead and spring-run chinook salmon. If successful and life stages are present, provide flows in the first five miles below Whiskeytown Dam, June 1 to November 1, to provide temperatures for juvenile rearing (65°F), holding of prespawning adults (60°F), and for egg incubation (56°F).	CDFG, USFWS, USBR	3406(b)(7), 3406(b)(12)	
3. Prevent further habitat degredation from effects of gravel mining and restore degraded channels.	CDFG, USFWS, USBR, BLM, Natural Resource Conservation Service (NRCS)	3406(b)(12)	
4. Provide fish passage facilities at McCormick-Saeltzer Dam and dredge sediment from behind the dam.	McCormick-Saeltzer Dam owners, CDFG, USFWS, USBR, NRCS	3406(b)(12)	

Action	Involved parties	Tools	Priority
5. Develop an erosion control and stream corridor protection program to prevent habitat degradation due to sedimentation and urbanization.	CDFG, USFWS, USBR, NCRS, BLM, Resource Conservation District (RCD)	3406(b)(12)	
6. Restore gravel recruitment and replenish gravel blocked by Whiskeytown Dam.	CDFG, USFWS, USBR	3406(b)(12), 3406(b)(13)	

Cow Creek

Action	Involved parties	Tools	Priority
1. Obtain agreements to provide suitable passage and early spawning flows for fall-run chinook salmon adults and adequate summer rearing habitat for juvenile steelhead.	Diverters, CDFG, USFWS, USBR, SWRCB	3406(b)(3)	
2. Implement the Anadromous Fish Screen Program.	Diverters, CDFG, USFWS, USBR	3406(b)(21)	
3. Improve passage at agricultural diversion dams.	Diverters, CDFG, USFWS, USBR		

Action	Involved parties	Tools	Priority
4. Fence riparian corridors to exclude livestock from selected areas within the tributary watersheds.	NCRS, Private land owners, CDFG		

Bear Creek

Action	Involved parties	Tools	Priority
1. Restore instream flows to allow suitable passage of juvenile and adult chinook salmon and steelhead during spring and early fall.	Diverters, CDFG, USFWS, USBR	3406(b)(3)	
2. Implement the Anadromous Fish Screen Program.	Diverters, CDFG, USFWS, USBR	3406(b)(21)	

Cottonwood Creek

Action	Involved parties	Tools	Priority
1. Establish limits on instream gravel mining operations by working with state and local agencies to protect spawning gravel in the valley sections of Cottonwood Creek and recruitment of spawning gravel to the Sacramento River.	COE, Shasta and Tehama Counties, California Division of Mines, CDFG		
2. Restore stream channel to avoid ACID Siphon from becoming a barrier to migration of spring-run, fall-run and steelhead.	ACID, Gravel operators		
3. Eliminate adult fall-run chinook stranding by either eliminating attraction flows in Crowley Gulch or by constructing abarrier at the mouth of Crowley Gulch.	ACID, CDFG, USFWS, USBR		
4. Facilitate watershed protection and restoration in order to reduce water temperatures to improve holding, spawning, and rearing habitat for salmonids and reduce siltation and sedimentation of existing spawning gravel.	Private land owners, CDFG		

Battle Creek

D—021984

Action	Involved parties	Tools	Priority
1. Continue to pass adult winter-run and spring-run chinook salmon above the Coleman National Fish Hatchery (CNFH) weir. After a disease-safe water supply becomes available to the CNFH, allow passage of fall-run and late fall-run chinook salmon and steelhead above the CNFH weir. Prior to acquiring a disease-safe water supply, keep the main hatchery water supply free of anadromous fish by blocking fish ladders at Wildcat Canyon, Eagle Canyon, and Coleman diversion dams.	CDFG, USFWS, USBR	3406(b)(11)	

Action	Involved parties	Tools	Priority
2. Increase flows past PG&E's hydropower diversions in two phases to provide adequate holding, spawning and rearing habitat for anadromous salmonids.	CDFG, PG&E, USFWS, NMFS, FER	3406(b)(3)	

Diversion	Months	Flow (cfs)
Keswick [b]	All year	30
North Battle Creek feeder [b]	September-November January-April May-August	40 40 30
Eagle Canyon [a]	May-November December-April	30 50
Wildcat [a]	May-November December-April	30 50
South [b]	May-November December-April	20 30
Inskip [b]	May-November December-April	30 40
Coleman [a]	September-April May-August	50 30

[a] First phase flows required to support winter-run and spring-run chinook salmon between the CNFH weir and the Coleman Powerhouse and Eagle Canyon Diversion Dams while a disease-safe water supply is being developed for CNFH.
[b] Second phase flows required to support fall-run chinook salmon above the CNFH weir, Coleman Powerhouse and Eagle Canyon Diversion Dams, after a disease-safe water supply is available to CNFH.

Action	Involved parties	Tools	Priority
3. Construct barrier racks to prevent adult salmon from entering Gover Diversion and the waste gates from the Gover Canal.	Gover Diversion Dam owners, CDFG, USFWS, USBR	3406(b)(21)	
4. Screen Orwick Diversion to prevent entrainment of juvenile salmonids and straying of adult salmon.	Orwick Diversion Dam owners, CDFG, USFWS, USBR	3406(b)(21)	
5. Screen tailrace of Coleman Powerhouse to eliminate attraction of adult chinook salmon and steelhead into an area with little spawning habitat and great potential of entrainment into the CNFH water supply.	CDFG, PG&E	3406(b)(21)	
6. Once both phases of upstream flow actions are completed and fish ladders on Coleman Powerhouse and Eagle Canyon Diversion Dams are opened, construct fish screens on all PG&E diversions.	CDFG, PG&E, USFWS, USBR	3406(b)(21)	
7. Improve fish passage in Eagle Canyon by modifying a bedrock ledge and boulders that are potential barriers to adult salmonids.	CDFG, USFWS, USBR		

Evaluation	Involved parties	Tools	Priority
1. Evaluate the effectiveness of fish ladders at PG&E diversions.	CDFG, PG&E	3406(e)(3)	
2. Evaluate the feasibility of establishing a spawning population of winter-run chinook salmon.	CDFG, USFWS, USBR	3406(e)(6)	

Evaluation	Involved parties	Tools	Priority
3. Evaluate all technical solutions for providing a disease-safe water supply to CNFH so that winter-run, spring-run and fall-run chinook salmon and steelhead would have access to an additional 41 miles of Battle Creek habitat.	USFWS, USBR, CDFG, NMFS	3406(b)(11), 3406(e)(6)	

Paynes Creek

Action	Involved parties	Tools	Priority
1. Provide minimum instream flows to improve spawning, rearing and migration opportunities for fall-run chinook salmon.	Diverters, CDFG	3406(b)(3)	
2. Restore and enhance spawning gravel.	CDFG		

Antelope Creek

Action	Involved parties	Tools	Priority
1. Provide adequate instream flows to allow suitable passage of juvenile and adult spring-run, fall-run and late fall-run chinook salmon during key migration periods.	Diverters, CDFG, USFWS, USBR		

Evaluation	Involved parties	Tools	Priority
1. Evaluate the creation of a more defined stream channel near the canyon mouth to facilitate fish passage.	Private land owners, CDFG, USFWS, USBR	3406(e)(3)	

Elder Creek

Action	Involved parties	Tools	Priority
1. Work with Tehama County to develop an erosion control ordinance to minimize sediment input into Elder Creek.	Tehama County, CDFG		

Evaluation	Involved parties	Tools	Priority
1. Evaluate the feasibility of constructing a fish passage structure over the Corning Canal Siphon.	CDFG, USFWS, USBR	3406(e)(3)	

Mill Creek

Action	Involved parties	Tools	Priority
1. Continue to provide adequate instream flows in the valley reach of Mill Creek to facilitate passage of adult and juvenile spring-run, fall-run and late fall-run chinook salmon and steelhead.	Mill Creek Watershed Conservancy (MCWC), Private land owners, CDFG, USFWS, USBR, CDWR	3406(b)(2), 3406(b)(3)	
2. Preserve the long-term habitat productivity of upper Mill Creek through cooperative watershed management.	CDFG, MCWC		
3. Improve spawning habitat in lower Mill Creek for fall-run and late fall-run chinook salmon.	CDFG, MCWC		
4. Maintain and restore riparian habitat along the lower reaches of Mill Creek.	City and county government agencies, Chico State University, CDFG		

Evaluation	Involved parties	Tools	Priority
1. Develop a permanent solution for fish passage at Clough Dam.	Tehama County Planning Commission, CDFG, CDWR		

Thomes Creek

Action	Involved parties	Tools		
1. Modify gravel mining methods to alleviate effects on salmonid spawning habitat.	Tehama County Planning Commission, CDFG, CDWR			
2. Employ the most ecologically sound timber extraction practices by implementing the Forest Plan on federal lands within the drainage.	Private land owners			
3. Modify and employ the most ecologically sound grazing practices by implementing the Forest Plan on Federal lands within the drainage.	Private land owners, USFS			

Action	Involved parties	Tools		
4. Reduce use of gravel diversion dams that may be barriers to migrating chinook salmon and steelhead.	Henleyville and Paskenta Diversion Dam operators, CDFG, USFWS, USBR			

Evaluation	Involved parties	Tools	Priority
1. Identify, prioritize and restore highly erodible areas.	CDFG	3406(e)(6)	
2. Conduct regular water quality monitoring throughout the entire creek to evaluate its suitability for salmon.	CDFG	3406(e)(6)	
3. Develop a release strategy for the Tehama-Colusa Canal into Thomes Creek to maintain flows from October to May if sufficient water is available from diversions at Red Bluff.	Tehama-Colusa Canal Authority, CDFG	3406 (b)(3)	

Deer Creek

D—021992

Action	Involved parties	Tools	Priority
1. Improve instream flows in the lower ten miles of Deer Creek to ensure passage of adult and juvenile spring-run and fall-run chinook salmon and steelhead over three diversion dams.	Deer Creek Conservancy (DCC), CDFG	3406 (b)(2), 3406 (b)(3)	
2. Protect and restore chinook salmon and steelhead habitat, and preserve the long-term productivity of upper Deer Creek.	DCC, CDFG	3406(b)(6)	
3. Improve salmon spawning habitat in lower Deer Creek for fall-run and late fall-run chinook salmon.	DCC, CDFG		
4. Negotiate long-term agreements to maintain and restore riparian habitat along the lower reaches of Deer Creek.	Private land owners, DCC, CDFG		
5. Plan and coordinate required flood management activities with minimal damage to the fishery resources and riparian habitat of lower Deer Creek.	DCC, CDFG		

Stony Creek

Evaluation	Involved parties	Tools	Priority
1. Determine the feasibility of restoring anadromous salmonids by evaluating water releases from Black Butte Dam, water exchanges with the Tehama-Colusa Canal, interim and long-term solutions at Red Bluff Diversion Dam, water quality, spawning gravel protection and restoration, riparian habitat protection and restoration, creation of a distinct creek channel, and passage at various water diversion structures.	Stony Creek Task Force, CDFG, COE, USFWS, USBR	3406 (e)(1), 3406 (e)(3), 3406 (e)(6)	

Big Chico Creek

Action	Involved parties	Tools	Priority
1. Substitute an alternative source of irrigation water for that currently supplied by the M&T Ranch pumps.	M&T Ranch owners, CDFG		
2. Repair the Iron Canyon Fish ladder.	CDFG		
3. Split low flows between Big Chico Creek and Lindo Channel.	City of Chico, CDFG, CDWR		
4. Replace spawning gravel in the channels modified for flood control.	Chico Parks Department, CDFG		
5. Repair the Lindo Channel weir and fishway at the Lindo Channel box culvert at the Five-Mile Diversion.	CDFG, CDWR, COE		

Action	Involved parties	Tools	Priority
6. Improve cleaning procedures at One-Mile Pool.	City of Chico, CDFG		
7. Protect primary summer holding pools for spring-run chinook salmon by obtaining the titles or conservation easements on land adjacent to the pools from willing sellers.	Private land owners, CDFG, USFWS, USBR		
8. Cooperate with local landowners to encourage revegetation of denuded stream reaches and establish a protected riparian strip.	Private land owners, CDFG		
9. Replace gravel in the flood-diversion reach of Mud Creek.	Butte County, CDFG, CDWR		

Butte Creek

Action	Involved parties	Tools	Priority
1. Obtain additional instream flows from Parrott-Phelan Diversion.	Diverters, CDFG, USFWS, USBR	3406(b)(3)	
2. Maintain a minimum 40 cfs instream flow below Centerville Diversion Dam.	CDFG, PG&E	3406(b)(3)	
3. Purchase existing water rights from willing sellers.	Diverters, CDFG, USFWS, USBR, SWRCB	3406(b)(3)	

Action	Involved parties	Tools	Priority
4. Build a new high-volume fish ladder at Durham Mutual Dam.	Diverters, CDFG		
5. Install fish screens on both diversions at Durham Mutual Dam.	Diverters, CDFG	3406(b)(21)	
6. Remove the Western Canal Dam and construct the Western Canal Siphon. If WCWD Dam is not removed and siphon not constructed, support CDFG's efforts to build a new high volume fish ladder and to install fish screens on both diversions at WCWD Dam.	Western Canal Water District (WCWD), CDFG	3406(b)(21)	
7. Remove McPherrin and McGowan Dams and provide an alternate source of water as part of Western Canal Dam removal and siphon construction. If McPherrin and McGowan Dams are not removed and alternate sources of water are supplied as part of the WCWD dam removal and siphon construction, support CDFG's efforts to build new high volume fish ladders at both dams and to install fish screens on both diversions.	Diverters, WCWD, CDFG	3406(b)(21)	
8. Acquire water rights as a part of the Western Canal siphon project.	WCWD, CDFG, SWRCB	3406(b)(3)	
9. Adjudicate water rights and provide water master service, or equivalent, for the entire creek, and enforce or initiate legal action on diverters who are violating water right allocations.	Diverters, CDFG, CDWR, SWRCB		
10. Build a new high-volume fish ladder at Adams Dam.	Diverters, CDFG		

Action	Involved parties	Tools	Priority
11. Install fish screens on both diversions at Adams Dam.	Diverters, CDFG	3406(b)(21)	
12. Build a new high-volume fish ladder at Gorrill Dam.	Diverters, CDFG		
13. Install fish screens on both diversions at Gorrill Dam.	Diverters, CDFG	3406(b)(21)	
14. Establish operational criteria for Sanborn Slough Bifurcation.	Diverters, CDFG		
15. Establish operational criteria for the East and West Barrows.	Diverters, CDFG		
16. Establish operational criteria for Nelson Slough.	Diverters, CDFG		
17. Install a fish screen at White Mallard Dam.	Diverters, CDFG	3406(b)(21)	
18. Eliminate salmon stranding at White Mallard Duck Club outfall.	Diverters, CDFG		
19. Rebuild and maintain existing culvert and riser at Drumheller Slough outfall.	Diverters, CDFG		
20. Install fish screens on Little Dry Creek pumps.	Diverters, CDFG	3406(b)(21)	

Action	Involved parties	Tools	Priority
21. Increase enforcement of fishing regulations.	CDFG		
22. Install a high-volume fish ladder at White Mallard Dam.	Diverters, CDFG		

Evaluation	Involved parties	Tools	Priority
1. Evaluate development of operational criteria for, and potential modification to Butte Slough outfall.	Diverters, CDFG	3406(e)(3)	
2. Evaluate alternatives or build a new high-volume fish ladder at East-West Diversion Weir.	Diverters, CDFG	3406(e)(3)	
3. Evaluate operational alternatives and establish operational criteria for Sutter Bypass Weir #2.	Diverters, CDFG	3406(e)(3)	
4. Evaluate operational alternatives and establish operational criteria for Sutter Bypass Weir #1.	Diverters, CDFG	3406(e)(3)	
5. Evaluate alternatives to facilitate fish passage including the installation of fish screens at Sanborn Slough Bifurcation Structure.	Diverters, CDFG	3406(b)(21), 3406(e)(3)	
6. Evaluate alternatives to facilitate fish passage including the installation of fish screens within Sutter Bypass where necessary.	Diverters, CDFG	3406(b)(21), 3406(e)(3)	
7. Evaluate operational alternatives and establish operational criteria for Sutter Bypass Weir #5.	Diverters, CDFG	3406(e)(3)	

Evaluation	Involved parties	Tools	Priority
8. Evaluate alternatives to facilitate fish passage including the installation of a high-volume fish ladder on Sutter Bypass Weir #2.	Water users, CDFG	3406(e)(3)	
9. Evaluate alternatives to facilitate fish passage including the installation of a high-volume fish ladder on Sutter Bypass Weir #1.	Water users, CDFG	3406(e)(3)	
10. Evaluate alternatives to facilitate fish passage including the installation of a high-volume fish ladder on Sutter Bypass Weir #5.	Water users, CDFG	3406(e)(3)	
11. Evaluate alternatives to facilitate fish passage including the installation of a high-volume fish ladder on Sutter Bypass Weir #3.	Water users, CDFG	3406(e)(3)	
12. Evaluate enhancement of fish passage at a natural barrier below Centerville Diversion Dam.	PG&E, CDFG	3406(e)(3)	
13. Evaluate potential to enhance fish passage at PG&E Diversion Dams and other barriers above Centerville Diversion Dam.	PG&E, CDFG		
14. Develop and enforce land use plans that create buffer zones between the creek and urban development.	City and county government agencies, Conservation groups, CDFG		

Evaluation	Involved parties	Tools	Priority
15. Develop a watershed management program.	Private land owners, Butte Creek Conservancy, CDFG		

Colusa Basin Drain (westside tributaries)

Evaluation	Involved parties	Tools	Priority
1. Investigate the feasibility of restoring access of anadromous fish to westside tributaries through development of defined migrational routes, sufficient flows, and adequate water temperatures.	CDFG	3406(e)(1), 3406(b)(3)	
2. If investigation of anadromous fish restoration in Colusa Basin Drain (Westside Tributaries) indicates little potential, evaluate the installation of an adult exclusion device at Knights Landing outfall.	CDFG	3406(e)(1)	

Miscellaneous small tributaries

D—022000

Evaluation	Involved parties	Tools	Priority
1. Encourage the restoration of small tributaries by evaluating the feasibility of screening or relocating diversions, switching to alternative sources of water for upstream diversions, restoring and maintaining a protected riparian strip, enforcing dumping ordinances, removing toxic materials, replacing bridge and ford combinations with bridges or larger culverts and installing siphons to prevent truncation of small streams at irrigation canals.	CDFG, USFWS, USBR	3406(e)(1), 3406(b)(3)	

LOWER SACRAMENTO RIVER AND DELTA TRIBUTARIES

Feather River

Action	Involved parties	Tools	Priority
1. Copntinue to provide adequate flows for adult and juvenile fall- and spring-run chinook salmon and steelhead.	CDWR, CDFG		
2. Improve flows for migration, spawning, incubation and rearing of American shad (April through June) when hydrologic conditions are adequate to minimize adverse effects to operations (water supply, storage, etc.).	Diverters, CDWR, CDFG	3406(b)(3)	

Evaluation	Involved parties	Tools	Priority
1. Evaluate the response of spawning salmonids to increased flows in the low-flow channel.	CDWR, CDFG	3406(e)(6)	

Evaluation	Involved parties	Tools	Priority
2. Evaluate the quality of spawning gravel in areas used by chinook salmon, and if indicated, consider gravel renovation or supplementation to enhance substrate quality.	CDWR		
3. Develop and utilize a temperature model as a tool for river management.	CDWR	3406(g)(2)	
4. Evaluate the distribution of Feather River Fish Hatchery chinook salmon in Central Valley stocks and determine genetic integrity of Feather River spring-run chinook salmon.	CDWR, CDFG	3406(e)(2)	
5. Identify and attempt to maintain adequate flows and temperatures in February through May for migration, spawning, incubation and rearing of white sturgeon and green sturgeon, consistent with actions to protect chinook salmon and steelhead.	CDFG, CDWR	3406(b)(3)	
6. Identify and remove physical and water quality barriers that impede access for white sturgeon and green sturgeon to spawning habitat and remove barriers or facilitate passage around these barriers.	CDFG, CDWR	3406(e)(3)	
7. Identify the extent of white sturgeon and green sturgeon entrainment at diversions and pumps and reduce or eliminate entrainment if found to be substantial.	CDFG, CDWR USFWS, USBR	3406(b)(21)	
8. Identify white sturgeon and green sturgeon spawning sites and evaluate the availability and use by adult sturgeon.	CDFG, CDWR	3406(e)(6)	
9. Determine the effects of poaching and fishing on the number of spawning white sturgeon and green sturgeon.	CDFG	3406(e)(6)	

Evaluation	Involved parties	Tools	Priority
10. Identify and implement actions that maintain mean daily water temperatures between 61°F and 65°F for at least one month from April 1 through June 30 for American shad spawning.	CDFG, CDWR	3406(b)(3)	

Yuba River

Action	Involved parties	Tools	Priority
1. Provide adequate flows in the lower Yuba River for all life stages of anadromous fish.	Yuba County Water Agency (YCWA), SWRCB, CDFG, USFWS, USBR	3406(b)(3)	
2. Improve flows for migration, spawning, incubation and rearing of American shad (April through June) when hydrologic conditions are adequate to minimize adverse effects to operations (water supply, storage, etc.).	YCWA, SWRCB, CDFG	3406(b)(3)	
3. Reduce and control instream flow ramping rates to avoid and minimize adverse effects to juvenile salmonids.	YCWA, PG&E, SWRCB, CDFG		
4. Maintain adequate instream flows and reservoir operations for temperature control.	YCWA, CDFG	3406(b)(3)	

D—022003

Action	Involved parties	Tools	Priority
5. Improve efficiency of screening devices at Hallwood-Cordua and Brophy-South Yuba water diversions, and construct screens at the Browns Valley water diversion and other unscreened diversions by continuing to implement the Anadromous Fish Screen Program.	Diverters, SWRCB, CDFG, USFWS, USBR	3406(b)(21)	
6. Construct or improve fish bypasses at Hallwood-Cordua and Brophy-South Yuba water diversions.	Diverters, SWRCB, CDFG, USFWS, USBR	3406(b)(21)	
7. Facilitate passage of spawning adult salmonids by maintaining appropriate flows through the fish ladders, or by modifying the fish ladders at Daguerre Point Dam.	YCWA, CDFG, COE		
8. Purchase streambank conservation easements to improve salmonid habitat and instream cover.	Private land owners, YCWA, BLM, USFWS, USBR		
9. Increase river patrols in areas where poaching is a concern.	CDFG		
10. Facilitate passage of juvenile salmonids by modifying the dam face of Daguerre Point Dam.	YCWA, CDFG, COE		

D—022004

Action	Involved parties	Tools	Priority
11. Operate reservoirs to provide adequate water temperatures for anadromous fish.	Yuba River Water Temperature Advisory Committee, SWRCB		

Evaluation	Involved parties	Tools	Priority
1. Evaluate the effectiveness of pulse flows for facilitating successful juvenile salmonid emigration.	YCWA, CDFG, USFWS, USBR	3406(b)(8)	
2. Evaluate whether enhancement of water temperature control via shutter configuration and management of cold water pools at New Bullards Bar Dam is effective, and modify the water release outlets at Englebright Dam if it is effective.	YCWA, CDFG, PG&E, USFWS, USBR	3406(g)(2)	
3. Identify and attempt to implement actions that will maintain mean daily water temperatures between 61°F and 65°F for at least one month from April 1 through June 30 for American shad.	YCWA, CDFG, USFWS, USBR	3406(g)(2)	
4. Evaluate the benefits of restoring stream channel and riparian habitats of the Yuba River, including the creation of side channels for off-stream spawning and rearing habitats for salmonids.	YCWA, CDFG	3406(e)(6)	

Bear River

Action	Involved parties	Tools	Priority
1. Provide adequate flows in the Bear River for all life stages of chinook salmon and steelhead.	South Sutter Water District (SSWD), SWRCB, CDFG	3406(b)(3)	
2. Provide adequate water temperature conditions for all life-stages of chinook salmon and steelhead.	SSWD, SWRCB, CDFG		
3. Implement the Anadromous Fish Screen Program.	Diverters, CDFG, USFWS, USBR	3406(b)(21)	
4. Monitor water quality, particularly at agricultural return outfalls.	Diverters, CDFG		
5. Negotiate removal or modification of the culvert crossing and other physical and chemical barriers impeding anadromous fish migration.	Patterson Sand and Gravel, CDFG, USFWS, USBR		

Evaluation	Involved parties	Tools	Priority
1. Complete an IFIM study to contribute to the understanding of the flows needed to protect all life stages of salmonids.	SSWD, CDFG, USFWS, USBR	3406(g)(4)	
2. Evaluate the extent to which white sturgeon and green sturgeon use the Bear River for spawning and rearing.	CDFG		

D—022006

Evaluation	Involved parties	Tools	Priority
3. Evaluate the extent that poaching or fishing reduces the numbers of adult anadromous fish.	CDFG		

American River

Action	Involved parties	Tools	Priority
1. Develop and implement a river regulation plan that meets the following flow objectives by modifying CVP operations, using (b)(2) water, and acquiring water from willing sellers.	Sacramento Area Water Forum (SAWF), CDFG, USBR, USFWS	3406(b)(1)(B), 3406(b)(2), 3406(b)(3)	

Month	American River minimum flow objectives[a] (cfs)			
	Wet[b]	Above and below normal	Dry and critical	Critical relaxation
October	2,500	2,000	1,750	800
Nov-ember-February	2,500	2,000	1,750	1,200
Mar-ch-May	4,500	3,000	2,000	1,500
June	4,500	3,000	2,000	500
July	2,500	2,500	1,500	500
August	2,500	2,000	1,000	500
September	2,500	1,500	500	500

[a] A multi-agency and interested party management team should be formed to review and adjust flows in consideration of carryover storage and hydrologic conditions as needed to provide for the long-term needs of anadromous fish. Flow objectives should be met for the entire reach of the American River downstream of Nimbus Dam.
[b] Year types should be based on an American River index, or on consideration of carryover storage and hydrologic conditions in the American River watershed.

Action	Involved parties	Tools	Priority
2. Develop a long-term water allocation plan for the American River watershed.	SAWF, CDFG, other water users, USFWS, USBR		
3. Reduce and control instream flow ramping rates and flow fluctuations to avoid and minimize adverse effects on juvenile salmonids.	USFWS, USBR, CDFG		
4. Reconfigure Folsom Dam "shutters" (penstock inlet ports) for improved management of Folsom Reservoir's cold water pool and better control over the temperature of water released downstream.	USFWS, USBR		
5. Replenish spawning gravel and restore existing spawning grounds.	USFWS, USBR	3406(b)(13)	
6. Improve the fish screen at Fairbairn Water Treatment Plant by continuing to implement the Anadromous Fish Screen Program.	City of Sacramento, CDFG, USFWS, USBR	3406(b)(21)	
7. Modify the timing and rate of water diverted from the river annually to reduce entrainment losses of juvenile salmonids.	City of Sacramento, other local water users, CDFG, USFWS, USBR		

Action	Involved parties	Tools	Priority
8. Develop a riparian corridor management plan to improve and protect riparian habitat and instream cover.	County of Sacramento, Sacramento Area Flood Control Association (SAFCA), COE, USFWS, USBR,		
9. Terminate current programs that remove woody debris from the river channel.	County of Sacramento, City of Sacramento, SAFCA, COE, USFWS, USBR, CDFG		
10. Conduct on-river patrols in areas where poaching is a concern.	CDFG		
11. Increase flows from April through June for American shad spawning, incubation and rearing, by modifying CVP operations, by using (b)(2) water, and by acquiring water from willing sellers when hydrologic impacts are adequate to minimize operations and in a manner that is consistent with recommendations for chinook salmon and steelhead.	SAWF, USFWS, USBR, CDFG	3406(b)(1)(B), 3406(b)(2), 3406(b)(3)	

Evaluation	Involved parties	Tools	Priority
1. Evaluate the effectiveness of pulse flows for facilitating successful emigration of juvenile salmonids.		3406(b)(8)	
2. Evaluate and refine a river regulation plan that provides flows to protect all life stages of anadromous fish based on water storage at Folsom Reservoir and predicted hydrologic conditions in the American River watershed.		3406(g)(2)	

Mokelumne River

Action	Involved parties	Tools	Priority
1. Provide adequate flows in the lower Mokelumne River for all life stages of chinook salmon and steelhead.	East Bay Municipal Utility District (EBMUD), Woodbridge Irrigation District (WID), FERC, CDFG, USFWS	3406(b)(3)	
2. Replenish gravel suitable for salmonid spawning habitat.	CDFG, EBMUD		
3. Cleanse spawning gravel of fine sediments and prevent sedimentation of spawning gravel.	CDFG, EBMUD		

Action	Involved parties	Tools	Priority
4. Reduce and control instream flow ramping rates and flow fluctuations to avoid and minimize adverse effects to juvenile salmonids.	CDFG, EBMUD		
5. Screen diversions in the Mokelumne River by implementing the Anadromous Fish Screen Program.	CDFG, USFWS, USBR	3604(b)(21)	
6. Maintain suitable water temperatures for all salmonid life stages.	EBMUD, CDFG		
7. Enhance and maintain the riparian corridor to improve streambank and channel rearing habitat for juvenile salmonids.	Riparian landowners, CDFG		
8. Establish and enforce water quality standards to provide optimal water quality for all life stages of salmonids.	CDFG		
9. Eliminate adverse effects of poaching and angling on salmonid production.	CDFG		
10. Eliminate or restrict gravel extraction operations in the Mokelumne River flood plain to prevent damage to potential spawning areas and encroachment of vegetation.	Gravel extractors, CDFG		

Evaluation	Involved parties	Tools	Priority
1. Evaluate the effectiveness of pulse flows to facilitate successful emigration of juvenile salmonids in the spring, and determine the efficacy in all water year types.	EBMUD, CDFG, USFWS, USBR	3406(b)(8)	

Evaluation	Involved parties	Tools	Priority
2. Evaluate and facilitate passage of spawning adult salmonids in the fall and juvenile salmonids in the spring past Woodbridge Irrigation District Diversion Dam and Lodi Lake.	WID, City of Lodi, EBMUD, CDFG, USFWS, USBR	3406(b)(21)	
3. Evaluate the incidence of predation on juvenile salmonids emigrating past Woodbridge Dam, and investigate potential remedial measures if necessary.	WID, EBMUD, CDFG	3406(e)(6)	
4. Evaluate the effects of extending the closure of the fishing season from 31 December to 31 March (and possibly to 1 June) to protect juvenile salmonids and adult steelhead and prevent anglers from wading on redds.	CDFG		

Cosumnes River

Action	Involved parties	Tools	Priority
1. Reduce water diversions or augment instream flows during critical periods for salmonids.	Diverters, CDFG		
2. Pursue opportunities to purchase existing water rights to ensure adequate flows for all life stages of salmonids.	CDFG, The Nature Conservancy (TNC), USFWS, USBR	3406(b)(3)	
3. Enforce Fish and Game Codes that prohibit construction of unlicensed dams.	CDFG		

Action	Involved parties	Tools	Priority
4. Continue to implement the Anadromous Fish Screen Program.	Diverters, CDFG, USFWS, USBR, TNC	3604(b)(21)	
5. Establish a riparian corridor protection zone.	TNC, Landowners, CDFG		
6. Rehabilitate damaged areas and remedy incompatible land practices to reduce sedimentation and instream water temperatures.	TNC, Landowners, CDFG		

Evaluation	Involved parties	Tools	Priority
1. Determine and evaluate instream flow requirements that ensure adequate flows for all life stages of all salmonids.	Diverters, TNC, CDFG	3406(e)(6)	
2. Evaluate and facilitate passage of adult and juvenile salmonids at existing diversion dams and barriers.	Diverters and dam builders, TNC, CDFG, USBR, USFWS,	3406(e)(3)	
3. Evaluate the feasibility of restoring and increasing available spawning and rearing habitat for salmonids.	TNC, CDFG, USBR, USFWS	3406(e)(6)	

D—022014

Calaveras River

Action	Involved parties	Tools	Priority
1. Provide adequate flows in the Calaveras River for all life stages of winter-run chinook salmon.	Calaveras County Water District (CCWD), Stockton East Water District (SEWD), CDFG, COE	3406(b)(3)	
2. Provide flows of suitable water temperatures for all salmonid life stages, including adult immigration, spawning, incubation, rearing, and juvenile emigration.	CDFG, USFWS, USBR		
3. Facilitate passage of adult and juvenile salmonids at existing diversion dams and barriers.	Diverters, CDFG	3406(b)(3)	
4. Implement the Anadromous Fish Screen Program.	Diverters, CDFG, USFWS, USBR	3604(b)(21)	
5. Monitor sport fishing and evaluate the need for regulations to protect salmonids.	CDFG		

SAN JOAQUIN BASIN

Merced River

Action	Involved parties	Tools	Priority
1. Supplement flows provided pursuant to the Davis-Grunsky Contract Number D-GGR17 and FERC License Number 2179 as needed to improve conditions for all life stages of chinook salmon.	Merced Irrigation District, Other water-rights holders, CDFG, CDWR, USFWS, USBR	Cooperative agreements, 3406(b)(3)	
2. Reduce adverse impacts of rapid flow fluctuations.	Merced I.D., CDFG, USFWS, USBR		
3. Improve watershed management to restore and protect instream and riparian habitat, including consideration of restoring and replenishing spawning gravel.	Landowners, Merced County, Natural Resources Conservation Service (NRCS), CDFG, USFWS, USBR		
4. Reduce or eliminate entrainment of juvenile salmon at riparian pumps and diversions.	Diverters, NMFS, CDFG, USFWS, USBR	3406(b)(21)	

Action	Involved parties	Tools	Priority
5. Provide additional law enforcement to reduce illegal take of salmon, stream alteration, and water pollution and to ensure adequate protection for juvenile salmon at pumps and diversions.	CDFG		
6. Establish a "streamwatch" program to increase public participation in river management.	CDFG, USFWS		

Evaluation	Involved parties	Tools	Priority
1. Identify and implement actions to provide suitable water temperatures for all life stages of chinook salmon; establish maximum temperature objectives of 56°F from October 15 through February 15 for incubation and 65°F from April 1 through May 31 for juvenile emigration.	Dam operators, CDFG, USFWS, USBR	3406(g)(2)	
2. Evaluate and implement actions to reduce predation on juvenile chinook salmon, including actions to isolate "ponded" sections of the river.	CDFG	3406(e)(6)	

Tuolumne River

Action	Involved parties	Tools	Priority
1. Implement a flow schedule as specified in the terms of the pending FERC order resulting from the New Don Pedro Project (FERC Proceeding P-2299-024). Supplement FERC agreement flows as needed by establishing cooperative agreements with the Tuolumne and Modesto irrigation districts (TID and MID), the City and County of San Francisco and other parties, and by acquisition of water.	City and County of San Francisco, TID MID, FERC, USFWS, USBR	3406(b)(3)	
2. Reduce adverse impacts of rapid flow fluctuations.	Water rights holders, Hydropower operators, USFWS, USBR		
3. Improve watershed management and restore and protect instream and riparian habitat, including consideration of restoring and replenishing spawning gravel.	Landowners, NRCS, CDFG, USFWS, USBR		
4. Reduce or eliminate entrainment of juvenile salmon at riparian pumps and diversions by implementing the Anadromous Fish Screen Program.	Diverters, CDFG, USFWS, USBR	3406(b)(21)	
5. Provide additional law enforcement to reduce illegal take of salmon, stream alteration, and water pollution and to ensure adequate protection for juvenile salmon at pumps and diversions.	CDFG		
6. Support the Tuolumne River Interpretive Center.	CDFG		

Evaluation	Involved parties	Tools	Priority
1. Identify and implement actions to provide suitable water temperatures for all life stages of chinook salmon; establish maximum temperature objectives of 56°F from October 15 through February 15 for incubation and 65°F from April 1 through May 31 for juvenile emigration.	Dam operators, CDFG, USFWS, USBR	3406(g)(2)	
2. Evaluate and implement actions to reduce predation on juvenile chinook salmon, including actions to isolate "ponded" sections of the river.	TID, MID, CDFG	3406(e)(6)	

Stanislaus River

Action	Involved parties	Tools	Priority
1. Implement a interim river regulation plan that meets the following flow schedule by supplementing the 1987 agreement between USBR and CDFG[a], through reoperation of New Melones Dam, use of (b)(2) water, and acquisition of water from willing sellers.	CDFG, USFWS, USBR, Oakdale Irrigation District, South San Joaquin Irrigation District, Stockton East Irrigation District	3406(b)(1)(B), 3046(b)(2), 3406(b)(3)	

Month	Stanislaus River flow schedules (cfs) by year type[b]				
	Wet	Above normal	Below normal	Dry	Critical
October	350	350	250	250	200
November-March	400	350	300	275	250
April	1,500	1,500	300/1500[c]	300/1500[d]	300/1500[e]
May	1,500	1,500	1500/300[c]	1500/300[d]	1500/300[e]
June	1,500	800	250	200	200
July-September	300	300	250	200	200
Total (taf)	468	410	313	257	247
Baseline (taf)	1,015	722	406	242	269
Unimpaired (taf)	1,772	1,291	920	631	449

[a] Existing flow requirements are 302 to 92 taf, based on the 1987 agreement between CDFG and USBR (CDFG and USBR 1987); actual schedule is determined on an annual basis and depends on available yield and carryover storage.
[b] Year type based on San Joaquin basin 60-20-20 index. Flow schedules apply from Goodwin Dam to the confluence with the San Joaquin River.
[c] In a below normal water year, April-May flow would be maintained for 45 days at 1500 cfs and 16 days at 300 cfs.
[d] In a dry water year, April-May flow would be maintained for 30 days at 1500 cfs and 31 days at 300 cfs.
[e] In a critical water year, April-May flow would be maintained at 1500 cfs for 30 days and at 300 cfs for 31 days.

Action	Involved parties	Tools	Priority
2. Improve watershed management to restore and protect instream and riparian habitat.	Landowners, CDFG, NRCS, USFWS, USBR		
3. Reduce or eliminate entrainment of juvenile salmon at riparian pumps and diversions by implementing the Anadromous Fish Screen Program.	Diverters, CDFG, NMFS, USFWS, USBR	3406(b)(21)	
4. Provide additional law enforcement to protect against illegal take of salmon, stream alteration, and water pollution and to ensure adequate screening of pumps and diversions.	CDFG		

Evaluation	Involved parties	Tools	Priority
1. Identify and implement actions to provide suitable water temperatures for all life stages of chinook salmon, consistent with efforts to maintain adequate flows to provide fish habitat. Establish maximum temperature objectives of 56°F from October 15 through February 15 for incubation and 65°F from April 1 through May 31 for juvenile emigration.	Dam operators, CDFG, USFWS, USBR	3406(g)(2)	
2. Evaluate and implement actions to reduce predation on juvenile chinook salmon.	CDFG	3406(e)(6)	

Evaluation	Involved parties	Tools	Priority
3. Evaluate use of the Stanislaus River by American shad and consider increasing flows and maintaining mean daily water temperatures between 61 °F and 65 °F for shad in April through June when hydrologic conditions are adequate to minimize adverse impacts to operations and in a manner consistent with meeting the needs of chinook salmon.	Dam operators, CDFG, USFWS, USBR	3406(g)(2), 3406(b)(1)(B), 3406(b)(2), 3406(b)(3)	

Mainstem San Joaquin River

Action	Involved parties	Tools	Priority
1. Implement a flow schedule that improves conditions for San Joaquin chinook salmon migrating through, or rearing in, the lower San Joaquin River and Sacramento-San Joaquin Delta.	In-river and tributary water managers and diverters, CDFG, SWRCB		
2. Develop and implement an export schedule that will protect San Joaquin chinook salmon migrating through, or rearing in, the Sacramento-San Joaquin Delta.	In-river and tributary water managers and diverters, CDFG, SWRCB		

D—022022

Action	Involved parties	Tools	Priority
3. Develop an equitable, integrated San Joaquin Basin plan that will meet outflow/export objectives identified under Actions 1 and 2.	In-river and tributary water managers and diverters, CDFG, SWRCB		
4. Reduce or eliminate entrainment of juvenile salmon at Banta-Carbona, West Stanislaus, Patterson, and El Soyo diversions by implementing the Anadromous Fish Screen Program in conjunction with other programs.	Irrigation or water management districts, CDFG	3406(b)(21)	
5. Reduce or eliminate entrainment of juvenile salmon at smaller riparian pumps and diversions on the mainstem San Joaquin River by implementing the Anadromous Fish Screen Program.	Diverters, CDFG	3406(b)(21)	
6. Prohibit the dredging of the Stockton ship channel during critical periods.	CDFG, CDWR		
7. Establish a basin-wide conjunctive water use program.	In-river and tributary water managers and diverters, CDFG, CDWR, USBR, USFWS,		

Action	Involved parties	Tools	Priority
8. Attempt to improve flows for migration of steelhead, consistent with efforts to maintain adequate flows for chinook salmon.	In-river and tributary water managers and diverters, CDFG	3406(b)(3)	

Evaluation	Involved parties	Tools	Priority
1. Identify and implement opportunities to improve watershed management to restore and protect instream and riparian habitat.	Landowners, CDFG	3406(e)(1)	
2. Identify and implement actions to maintain suitable water temperatures or minimize length of exposure to unsuitable water temperatures for all life stages of chinook salmon in the San Joaquin River and Delta.	In-river and tributary water managers and diverters, CDFG	3406(g)(2)	
3. Identify and implement actions to reduce predation on juvenile chinook salmon.	CDFG	3406(e)(6)	
4. Identify and attempt to maintain adequate flows for migration, spawning, incubation and rearing of white sturgeon and green sturgeon from February through May that are consistent with actions to protect chinook salmon.	In-river and tributary water managers and diverters, CDFG, CDWR	3406(b)(1)(B), 3406(b)(2), 3406(b)(3)	
5. Identify and attempt to implement actions that will maintain mean daily water temperatures between 61°F and 65°F for at least one month between April 1 and June 30 for American shad.	CDFG	3406(g)(2)	

D—022024

SACRAMENTO-SAN JOAQUIN DELTA

Improvements to aquatic habitat in the Delta are essential to restore the natural production of anadromous fish in the Central Valley because all species and races of fish use the Delta at some stage in their life history.

Recent actions to improve fish habitat in the Delta are described in the 15 December 1994, Principles of Agreement on Bay-Delta Standards between the State of California and the Federal Government (i.e., CALFED Bay-Delta Agreement) and the SWRCB's Water Quality Control Plan (WQCP; SWRCB 1995).

Both the Bay-Delta Agreement and WQCP (SWRCB 1995) require operational flexibility of state and federal water projects to provide environmental protection for anadromous fish with minimal costs to water users. The WQCP delegates substantial authority, subject to veto by the SWRCB Executive Director, to an "Operations Coordination Group" (Ops Group). The Ops Group utilizes operational flexibility of the State Water Project (SWP) and Central Valley Project (CVP) in such ways that species using the estuary receive more protection than they would have received by strict adherence to the standards.

Operational flexibility has two components, application targets and supplemental actions. Application targets identify the variance in the timing and nature of operational requirements in the WQCP, principally gate operations and variation in export limitations in dry years.

Supplemental actions consist of changes in operations beyond those required by the WQCP. These actions allow the Ops Group to take advantage of opportunities as they become available without affecting water users, such as opportunities to augment flow and restrict exports in wet years. The CVPIA can enable supplement actions to occur in other water year types through two programs, the management of 800,000 acre-feet of CVP water [Section 3406(B)(2)] and the purchase of water from willing sellers [Section 3406(b)(3)], to avoid unreasonable water supply impacts on water users.

The following actions include potential near-term (≤5 years) and long-term (>5 years) restoration actions that are intended to be consistent with and supportive of the long-term solution for the Delta being developed by the CALFED process. The actions are divided into four categories: 1) application targets; 2) supplemental actions involving flows, exports, barriers and cross channel

operations that are beyond the WQCP; 3) other actions deemed reasonable yet not directly related to the WQCP or Bay-Delta Agreement, although they may be applicable to Category III in the Agreement; and 4) a list of evaluations applicable to the Delta.

Application target	Involved parties	Tools	Priority
1. Close Delta Cross Channel (DCC) up to 45 days during November through January when juvenile salmon enter the Delta or flow or turbidity changes trigger salmon migration.	CALFED agencies	WQCP, Bay-Delta Agreement, 3406(b)(1)(B)	
2. Reduce export rates when DCC is closed with target of positive net down stream flows in western San Joaquin River at Jersey Point (i.e., Qwest).	CALFED agencies	WQCP, Bay-Delta Agreement, 3406(b)(1)(B)	
3. Maximize DCC closure during May through June when Sacramento River salmon are present, open when striped bass or Delta smelt are abundant in lower San Joaquin River.	CALFED agencies	WQCP, Bay-Delta Agreement, 3406(b)(1)(B)	
4. Achieve an average export:inflow ratio of 45% during February in dry years by increasing the ratio to ~55% in early February and decreasing the ratio to ~35% in late February, when winter run chinook salmon smolts are abundant.	CALFED agencies	WQCP, Bay-Delta Agreement, 3406(b)(1)(B)	
5. Fill San Luis Reservoir in early fall (September and October) using SWP pumps instead of CVP so that water released from reservoirs for export exceed CVP capability.	CALFED agencies	WQCP, Bay-Delta Agreement, 3406(b)(1)(B)	

Supplemental action	Involved parties	Tools	Priority
6. Limit SWP and CVP exports to 1,500 cfs or a Vernalis inflow:SWP and CVP export ratio of 5 to 1 during the April through May pulse flow period.	CALFED agencies	3406(b)(2), 3406(b)(3)	
7. Decrease the combined SWP and CVP exports to 1,500 cfs beyond 30 days when San Joaquin River chinook salmon smolts are present.	CALFED agencies	3406(b)(2), 3406(b)(3)	
8. Increase the Vernalis pulse flow period beyond 30 days when San Joaquin River chinook salmon smolts are present and temperatures are below 68°F.	CALFED agencies	3406(b)(2), 3406(b)(3)	
9. Limit exports to that resulting in a positive Qwest flow when the DCC is closed during November through January.	CALFED agencies	3406(b)(2), 3406(b)(3)	
10. Limit exports to that resulting in a positive Qwest flow during July when striped bass or Delta smelt are abundant in the lower San Joaquin River and the southern Delta.	CALFED agencies	3406(b)(2), 3406(b)(3)	
11. Construct, contingent upon evaluation and development of acceptable operating criteria, a permanent gated barrier facility at the head of Old River to increase the survival of emigrating juvenile chinook salmon and to improve upstream migration conditions for adult chinook salmon.	CALFED agencies	3406(b)(2), 3406(b)(3)	
12. Reduce riparian diversions in the Delta during the April through May pulse flow period and at other times when anadromous fish are abundant.	CALFED agencies	3406(b)(2), 3406(b)(3)	

Other action	Involved parties	Tools	Priority
13. Develop and implement a program to mitigate for fishery impacts resulting from operations of the Contra Costa Canal Pumping Plant No. 1.	CCWD, USFWS, USBR	3406(B)(5)	
14. Develop and implement a program to mitigate for fishery impacts associated with operations of the Tracy Pumping Plant.	CDFG, USFWS, USBR	3406(B)(4)	
15. Supplement Delta outflow, when supplies are available, for migration and rearing of white sturgeon, green sturgeon, striped bass, and American shad in the Delta, by modifying CVP operations and using water available under the CVPIA [3406(b)(2) and (3)] in a manner that is consistent with recommendations for chinook salmon and steelhead.	USFWS, USBR	3406(b)(1)(B) 3406(b)(2) 3406(b)(3)	
16. Reduce predation at the CVP and SWP fish salvage facilities and implement other actions to improve survival of salvaged target species.	USFWS, USBR	3406(b)(4)	
17. Reduce loss and entrainment of eggs, larvae, and juveniles of anadromous fishes by screening or relocating riparian diversions in the Delta.	USFWS, USBR	3406(b)(21)	
18. Develop and implement a program which provides for modified operations and new or improved control structures at the DCC and Georgiana Slough during times when high numbers of striped bass eggs, larvae, and juveniles are in the areas.	CDFG, USFWS, USBR	3406(b)(14)	
19. Provide additional funding for increased enforcement of fishery regulations in the Delta and public education of anadromous fish issues, where appropriate.	CDFG, USFWS, USBR	3406(b)(1)	

Other action	Involved parties	Tools	Priority
20. Increase public education efforts and hazardous waste pick-ups to minimize water quality impacts associated with the use of pesticides and other hazardous materials.	Local groups, Regional WRCB, SWRCB, USFWS, USBR	3406(b)(1)	
21. Operate state and federal pumps to interchangeably minimize fish losses and predation at facilities.	CDWR, SWRCB, USFWS, USBR	WQCP, Bay-Delta Agreement	

Evaluation	Involved parties	Tools	Priority
1. Develop and implement actions to avoid losses of juvenile anadromous salmonids resulting from unscreened or inadequately screened diversions in the Sacramento-San Joaquin Delta and Suisun Marsh.	IEP agencies	3406(b)(21)	
2. Evaluate and implement actions to prevent the development of a water quality barrier to adult Striped bass migration in the San Joaquin River near Stockton.	Regional WRCB, IEP agencies		
3. Evaluate and establish operating criteria for the head of Old River barrier through a comprehensive program in the south Delta.	Riparian diverters, IEP agencies, CALFED agencies		

Evaluation	Involved parties	Tools	Priority
4. Evaluate the effects of net reverse flows upon juvenile salmonids migrating in the western San Joaquin River near the mouth of the Mokelumne River with an intensive monitoring program of marked (radio, sonic, or other tags) and unmarked smolts.	SWP and CVP contractors, IEP agencies		
5. Evaluate potential benefits and opportunities to increase salmonid production through improved riparian habitats in the Delta.	SWP and CVP contractors, TNC, IEP agencies		
6. Evaluate opportunities to provide modified operations and a new or improved control structure for the DCC and Georgiana Slough to assist in the successful migration of anadromous salmonids.	SWP and CVP contractors, TNC, IEP agencies		
7. Evaluate alternative water conveyance and storage facilities for the SWP and CVP in the Delta.	SWP and CVP contractors, TNC, IEP agencies		
8. Evaluate benefits of DCC closure to anadromous fish relative to time of day and tidal stage.	SWP and CVP contractors, IEP agencies	)	
9. Evaluate opportunities to increase rearing habitat for chinook salmon and striped bass in the Delta, including island formation.	SWP and CVP contractors, TNC, IEP agencies		

Evaluation	Involved parties	Tools	Priority
10. Evaluate feasibility of Delta channel barriers and other technologies to aid and guide fish migrating from the north, south, and east.	SWP and CVP contractors, TNC, IEP agencies		
11. Evaluate riparian restoration opportunities, such as conservation easements on fencing programs, that are coordinated with restoration of rearing habitats and consistent with flood control and other objectives.	Local interests, SWP and CVP contractors, TNC, IEP agencies		
12. Evaluate opportunities to reduce the number of Delta diversions through land retirement and consolidation of diversion points.	Local diverters, IEP agencies		
13. Evaluate existing angling regulations in cooperation with local angling groups to identify options that would support the doubling goal, including catch and release regulations for green sturgeon.	Angler groups, CDFG		
14. Evaluate land retirement as a means of reducing levee instability, improving water quality and riparian and rearing habitats, and reducing the number of diversions in the Delta.	Local diverters, IEP agencies		
15. Evaluate opportunities to develop stream channel buffer zones to enhance riparian areas and reduce sedimentation.	Local diverters, IEP agencies		
16. Sponsor workshops to review and clarify existing scientific information regarding the effects of export pumping.	SWP and CVP contractors, IEP agencies		

Evaluation	Involved parties	Tools	Priority
17. Develop the scientific basis to evaluate pulse flow recommendations, including assessment of the tradeoffs between chinook salmon migration and Delta smelt habitat. Sponsor workshops to review and discuss the existing data.	SWP and CVP contractors, IEP agencies		
18. Reevaluate the value and applicability of Qwest as an index of Delta conditions. Examine other potential measures of Delta condition.	SWP and CVP contractors, IEP agencies		

CENTRAL VALLEY-WIDE

Action	Involved parties	Tools	Priority
1. Support programs to provide eductional outreach to local communities, including programs like Salmonids in the Classroom, Aquatic Wild, and Adopt a Watershed.	Local schools, CDFG, USFWS, NMFS		

Evaluation	Involved parties	Tools	Priority
1. Evaluate the need to revise harvest regulations to increase spawning escapement of naturally produced chinook salmon.	CDFG, Pacific Fisheries Management Council (PFMC)		
2. Evaluate the potential to modify hatchery procedures to benefit native stocks of salmonids.	CDFG, USFWS, USBR		

Evaluation	Involved parties	Tools	Priority
3. Evaluate and avoid potential competitive displacement of naturally produced juvenile salmonidswith hatchery-produced juveniles by implementing release strategies for hatchery-produced fish designed to minimize detrimental interactions.	USFWS, USBR		
4. Evaluate and implement specific hatchery spawning protocols and genetic evaluation programs to maintain genetic diversity in hatchery and natural stocks.	USFWS, USBR		
5. Evaluate the transfer of disease between hatchery and natural stocks.	USFWS, USBR		
6. Evaluate effects of trace elements and organic contaminants, especially selenium and PCBs, on the health of adult sturgeon, the viability of their gametes, and development of their offspring.	CDFG		
7. Evaluate a program to tag and fin-clip all or a significant portion of hatchery-produced fish as a means of collecting better information regarding harvest rates on hatchery and naturally produced fish and effects of hatchery-produced fish on naturally-produced fish.	CDFG, CDWR, USFWS, USBR, NMFS, EBMUD		

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Evaluation	Involved parties	Tools	Priority
1. Evaluate the need to revise harvest regulations on both sport and commercial fishers to increase spawning escapement of naturally produced chinook salmon.	Pacific Fisheries Management Council (PFMC), CDFG		

Evaluation	Involved parties	Tools	Priority
2. Evaluate the impacts of sea lions on chinook salmon production.	PFMC, CDFG, NMFS, USFWS		
3. Evaluate the impacts of foreign, open-ocean harvest on Central Valley chinook salmon and steelhead stocks.	PFMC, NMFS, CDFG		

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APPENDICES

A. Template for organization of detailed information on specific actions

The AFRP has developed a draft template containing the following information for each of the actions listed in the Restoration Plan.

Location: Identifies the drainage including specific location(s) of the action, if applicable.

Action: Action identified in the Restoration Plan.

Rank: Rating relative to other actions in the drainage.

Objective: Identifies species or race(s) of anadromous fish primarily affected and problem(s) solved by or intended effect(s) of the action.

Description: Describes the action in detail, including background, context, and reasons for implementing the action.

Monitoring needs: Identifies activities, including variables to observe, needed to evaluate the effectiveness of the action.

Predicted biological benefits: Identifies anticipated biological benefits, preferably in quantitative terms, focusing on anadromous fish or their habitat.

Issues: Identifies factors potentially influencing initiation and completion of the action.

Involved agencies: List government agencies involved and describes their roles (e.g., lead or supporting).

Key stakeholders: List stakeholders (i.e., individuals, water user groups, conservation groups, and sport and commercial fishing groups affected by the action in a specific drainage).

Deliverables: List products (e.g., progress reports or evaluations) completed during implementation.

Schedule: Time frame showing key events (e.g., start-completion dates, time of deliverables, and monitoring needs).

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Estimated cost to completion: Total costs from planning to completion, including permits, environmental documentation, and monitoring. Potential for schedule and budget revisions should be identified.

Funding: Annual budget identifying funding sources (e.g., CVPIA, Category III, Four Pumps Mitigation).

Status: Describes stage of development and accomplishments, future activities and milestones, and impediments.

CVPIA implementation tools: Identifies applicable section(s) of the CVPIA.

Manager: Identifies manager designated by the lead agency or group.

B. Production targets for chinook salmon in each stream

Preliminary estimated production targets for chinook salmon. Data for rivers without a race designation are for fall-run chinook salmon.

Race and river	Production targets
All races combined[a]	990,000
Fall run	750,000
Late-fall run	68,000
Winter run	110,000
Spring run	68,000
Sacramento River	
Fall run	230,000
Late-fall run	44,000
Winter run	110,000
Spring run	59,000
Clear Creek	7,100
Cow Creek	4,600
Cottonwood Creek	5,900
Battle Creek	
Fall run	10,000
Late-fall run	550
Paynes Creek	330
Antelope Creek	720
Mill Creek	
Fall run	4,200
Spring run	4,400
Deer Creek	
Fall run	1,500
Spring run	6,500
Miscellaneous creeks	1,100
Butte Creek	
Fall run	1,500
Spring run	2,000
Big Chico Creek	800
Feather River	170,000
Yuba River	66,000
Bear River	450
American River	160,000
Mokelumne River	9,300
Cosumnes River	3,300
Calaveras River	
Winter run	2,200
Stanislaus River	22,000
Tuolumne River	38,000
Merced River	18,000

[a]Targets for each of the races of chinook salmon may not add up to the target for all races combined due to rounding errors.

C. AFRP Position Paper

Presented in its entirety below is a document titled "Position Paper for Development of the Central Valley Anadromous Fish Restoration Program".

POSITION PAPER FOR DEVELOPMENT OF THE CENTRAL VALLEY ANADROMOUS FISH RESTORATION PROGRAM

INTRODUCTION

The Plan of Action (POA) for the Central Valley Anadromous Fish Restoration Program (Program) identifies the steps necessary to develop the Program (USFWS 1994). One of the steps included the preparation of a Position Paper to be developed by the Core Group. This document is a draft of the Position Paper described in the POA.

This Position Paper is a reference document for use by the Core Group and the technical teams to guide Program development. Because it was impossible to anticipate all issues prior to drafting the Position Paper, this paper will be amended and supplements added as needed. To determine if your copy is current and to request copies of the Position Paper, contact the Public Information Officer, Central Valley Fish and Wildlife Restoration Program, 2800 Cottage Way, Sacramento, California 95825, (916) 978-4460.

The paper is divided into three sections: (1) Program goal and definitions, (2) Intent of Title 34, and (3) Implementation criteria. The first section states the Program goal and develops general definitions for each of the terms used in the Program goal. The second section presents and interprets the intent of Title 34 and reexamines some of the definitions presented in the first section. These first two sections lay the foundation for the last section.

In the last section, implementation criteria are discussed for the 1967-1991 (baseline) period and for the future. Discussions of implementation criteria are separated because the two periods require different criteria. As discussed later in this paper, limitations are imposed by the type or quantity of data collected during the baseline period. Future monitoring programs may be designed to avoid these limitations.

PURPOSE OF POSITION PAPER

The purposes of the Position Paper are two-fold: (1) to explain or clarify the Core Group's position on issues related to developing the Program and (2) to document reasons used to develop these positions.

PROGRAM GOAL AND RELATED DEFINITIONS

Title 34 requires that "...natural production of anadromous fish in Central Valley rivers and streams be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967-1991..." (Section 3406[b][1]). Several terms need to be clearly defined before the program can be designed to meet this requirement: natural production, anadromous fish, Central Valley rivers and streams, sustainable, long-term basis, and average levels.

Natural Production

Title 34 defines natural production as: "... fish produced to adulthood without direct human intervention in the spawning, rearing, or migration processes" (Section 3403[h]). To apply this definition, we must develop an understanding of the meaning of each of the components of the definition. Important components that have been identified to date are the following: production, adulthood, and direct human intervention.

Production

Ricker (1958) defined production as "the total elaboration of new body substance in a stock in a unit of time, irrespective of whether or not it survives to the end of that time." Although Ricker's definition includes changes in mass as well as numbers of fish, Title 34 specifies "... fish produced to adulthood..." and therefore production will refer to numbers of fish produced.

Because a fish can only be "...produced to adulthood..." once in its lifetime, an individual fish should not be counted twice. In addition, production should be measured over a discrete time interval. Because all stocks under consideration are seasonal spawners, **a direct and simple approach will be to count the first-time spawners each spawning season.**

Ricker's definition also states that a fish is counted toward production for the time period over which production is being measured "...irrespective of whether or not it survives to the end of that time". Using Ricker's definition, juvenile fish that did not survive to adulthood would be counted. The definition of natural production in Title 34 specifies "... fish produced to adulthood..." and therefore does not count juvenile fish. On the other hand, Title 34 does not discriminate between adult fish that return to spawn and those taken in recreational and commercial fisheries. Because Ricker's definition includes fish that do not survive to the end of the time period, and because the definition of natural production in Title 34 specifies fish produced to adulthood, **all naturally produced, adult fish shall be counted, including those that are harvested prior to spawning.**

Including harvested fish is consistent with the definition of production in the California Salmon, Steelhead Trout and Anadromous Fisheries Program Act. The California Act defines production as "the survival of fish to adulthood as measured by abundance of the recreational and commercial catch together with the return of fish to the states spawning streams." Because both the Federal and State acts have similar purposes and goals, and because implementation of both acts should be coordinated, it is convenient that the definitions of production being implemented for both acts are similar.

Whether or not a fish attains adulthood is key to determining whether or not to count that fish toward the production goal. Adulthood is defined below.

Adulthood

Section 3403(h) includes the phrase "...fish produced to adulthood..." as part of the definition of natural production. Adulthood is not defined within Title 34. Adulthood is generally defined as the state, condition or quality of being fully developed and mature. Applying this definition to fish is complicated by the fact that most fish continue to grow throughout life (i.e., cessation of growth can't be used to indicate full development) and may become sexually mature several times during their lifetime (i.e., although developed gonads can be used to indicate maturity, lack of developed gonads cannot be used to indicate immaturity). Because the presence or absence of external characters can't always be used to identify adult fish, and because sexual maturity (i.e., developed gonads) is a transitory state, fishery managers often use size or age criteria to indicate maturity.

An adult fish will be defined as one that is capable of reproduction. Ability to reproduce should be based on some external characteristic, such as size. Because Title 34 requires that production be compared between baseline and goal periods, the same criteria for determination of adulthood will be applied to both periods.

Direct Human Intervention

The definition of natural production precludes "...direct human intervention..." in the spawning, rearing, or migration processes of an individual, naturally produced fish. A definition of direct human intervention is key to understanding the definition of natural production. Humans have pervasively intervened in the structure and function of the Sacramento-San Joaquin system. All anadromous fish that spawn in the system have been impacted by this intervention. Indeed, Title 34 has as one of its purposes "...to address impacts of the Central Valley Project on fish, wildlife, and associated habitats..." (Section 3402[b]). But not all human intervention is direct. The word direct is an important component of the phrase "...direct human intervention...".

Direct human intervention is any action taken in the absence of intervening elements. Any form of intervention that requires handling of fish is direct intervention due to a lack of intervening elements. Any action that includes one or more intervening elements would be considered indirect intervention.

Hatchery and artificial propagation, including supplementation and out-planting of eggs or any other life-stage, requires handling of fish by humans during the spawning and rearing processes and therefore are forms of direct intervention. Transporting fish, including truck and barge transport, and fish salvage require capture and handling of fish during the rearing or migration process and therefore are forms of direct intervention. Hatchery and artificial propagation, transport and salvage of fish, or any process that requires handling of any life-stage of fish will be considered direct human intervention.

Title 34 clearly states that fish produced with direct human intervention should not be included in counts of natural production. In developing the Program, we will avoid counting hatchery-produced fish or fish produced with any other form of direct human intervention in counts of natural production. The Core Group has determined that there will be one exception to this rule: the progeny of naturally spawning fish salvaged at the John E. Skinner Delta Fish Protective Facility and the Tracy Fish Protective Facility, if they reach adulthood, will be counted as naturally produced.

An example of a form of intervention that does not fit the definition of direct intervention is flow manipulation. When we manipulate flow to benefit fish, flow acts as the intervening element. Humans directly alter flows and flows alter fish spawning, rearing, or migration processes. Therefore, flow manipulation is not a direct but an indirect form of intervention. Construction of fish ladders, screens and barriers are forms of indirect intervention because each of these structures act as the intervening element. Reservoir or flow manipulations (including Delta flows and flows to maintain desired stream temperatures), ladders, screens, barriers, and other forms of habitat alteration and enhancement activities will not be considered direct human intervention because each of these is or has an intervening element and does not require handling of fish.

Because the definition of natural production in Title 34 includes the phrase "...produced to adulthood...", fish that are not subject to direct human intervention until after they reach adulthood would still be considered naturally produced. For example, a naturally produced fish that returned to a hatchery and was spawned in the hatchery would be considered naturally produced. Obviously, its progeny would not be considered naturally produced because they were produced in a hatchery. Similarly, naturally produced adult fish whose migration was subject to direct human intervention would still be considered naturally produced, although their progeny would not be considered naturally produced.

Anadromous Fish

Title 34 defines anadromous fish as "...those stocks of salmon (including steelhead), striped bass, sturgeon, and American shad that ascend the Sacramento and San Joaquin rivers and their tributaries and the Sacramento-San Joaquin Delta to reproduce after maturing in San Francisco Bay or the Pacific Ocean" (Section 3403[a]). This definition identifies five groups or species of fish: salmon, steelhead, striped bass, sturgeon, and American shad. The American Fisheries Society recognizes steelhead as the common name for the anadromous form of *Oncorhynchus mykiss* and striped bass and American shad as the common names for *Morone saxatilis* and *Alosa sapidissima* (AFS 1991). Clearly, Title 34 includes these species in the definition of anadromous fish. The names salmon and sturgeon both include multiple species of fish and the meaning of these terms in relation to Program development needs clarification. The term "stocks" in the definition of anadromous fish also needs clarification.

Salmon - Salmon is a common name for at least six species of fish. Five species of salmon have been observed in the Sacramento River: chinook (*O. tshawytscha*), coho (*O. kisutch*), sockeye (*O. nerka*), pink (*O. gorbuscha*), and chum (*O. keta*) salmon (Moyle 1976, Fry 1973). Chinook salmon are common in the Sacramento-San Joaquin system, the other four species are rare. Based on observations of adults during 1949 through 1958, Hallock and Fry (1967) concluded that sockeye, pink, and chum salmon entered the Sacramento River regularly enough to be regarded as very small runs, but that coho salmon were so scarce and irregular that they should be regarded as strays. Juvenile coho salmon were planted in Mill Creek in 1956, 1957, and 1958, but by 1963 coho salmon were almost as scarce as they had been before the introductions (Hallock and Fry 1967). During the baseline period, there is no evidence that coho, sockeye, pink, or chum salmon maintained self-sustaining spawning runs in the Central Valley (Fisher pers. comm.). Because the definition of anadromous fish specifies "...salmon... that ascend the Sacramento and San Joaquin rivers...to reproduce..." and because chinook salmon is the only salmon known to reproduce in the system on a regular basis during the baseline period, the use of the word salmon in the definition will be interpreted to mean chinook salmon.

Sturgeon - Two species of sturgeon are found in the Sacramento-San Joaquin system: white sturgeon (*Acipenser transmontanus*) and green sturgeon (*A. medirostris*) (Moyle 1976). Because both species of sturgeon reproduce in the Sacramento-San Joaquin system, the word sturgeon will be interpreted to include white and green sturgeon.

In summary, **the species of anadromous fish identified by Title 34 that reproduce in the Sacramento-San Joaquin system include chinook salmon, steelhead, striped bass, white sturgeon, green sturgeon, and American shad.** The Program

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will be designed to double the natural production of the anadromous forms of these six species.

Other anadromous fish - Title 34 does not identify several species of anadromous fish that spawn in Central Valley rivers and streams. These include threespine stickleback, brown trout, and two species of lamprey and smelt (Fry 1973). The Program will not establish restoration goals specific to these species.

Stocks

For purposes of the Program, **a stock is defined as a group of individuals which are more likely to mate with each other than with individuals not included in the group.** The term stock describes a fish population that spawns in a particular stream, or stream reach, at a particular season and that do not interbreed to a substantial degree with any group spawning in a different place, or in the same place at a different time. This definition does not rely upon absolute reproductive barriers. In fisheries management, stocks are recognized to maintain and improve the genetic basis for management.

Several stocks which meet this definition are already recognized. For example, chinook salmon are divided into several races based on the season during which they enter the rivers to begin their upstream spawning migrations as follows: fall, late-fall, winter, and spring runs. Others stocks which might be recognized in the future will likely become stocks of special concern.

Good evidence exists for salmon and steelhead that these species return to their natal streams to spawn. There is some evidence and little reason not to expect that the same relationship holds for some of the other anadromous species. As stated in the POA for the Program, the objective of the Program will be to double the natural production of all species and races within specific individual streams, and to preserve genetic stocks. If it proves unfeasible to double the natural production of a species or race within a specific stream, the unmet production increment will be transferred to other individual streams in the following order of priority: (1) another stream within the same drainage system, (2) another stream within the larger basin, such as the Sacramento River Basin, and (3) any stream within the Central Valley.

Central Valley Rivers and Streams

For the purposes of the Program, **Central Valley rivers and streams are defined as all rivers, streams, creeks, sloughs and other watercourses, regardless of volume and frequency of flow, that drain into the Sacramento River basin, the San Joaquin River basin downstream of Mendota Pool, or the Sacramento-San Joaquin Delta upstream of Chipps Island.**

Sustainable

Sustainable means capable of being maintained or kept in existence. In Title 34, sustainable refers to natural production, which is defined as "... fish produced to adulthood without direct human intervention...." Elimination of direct human intervention as a legitimate alternative requires reliance on restoration and maintenance of habitat conditions that allow anadromous fish populations to sustain themselves at levels consistent with numeric restoration goals. Therefore, in the context of Title 34, **sustainable is defined as capable of being maintained at target levels without direct human intervention in the spawning, rearing or migration processes.** Production levels specified by numeric goals will be considered sustainable when they are maintained under the entire range of conditions resulting from legal human activities, as superimposed on natural variability inherent in the system. Human activities shall include, but not be limited to, agricultural diversion and discharge, exports, flow manipulation, water pollution, dredge and fill, channel modification and damming.

There is an element of time implicit in sustainability. Therefore, if natural production is to be sustainable, modifications to system operations as well as improved physical habitat and water quality must be provided into the future. Title 34 requires that "...natural production...be sustainable, on a long-term basis" and provides for annual funding without a specified expiration date. The intent of Title 34 is that numeric restoration goals continue to be realized or exceeded in perpetuity.

Long-Term Basis

Long-term will encompass at least several generations of fish (not less than 5) over a variety of hydrologic conditions (to allow for natural variation in production) and will continue indefinitely.

Average Levels

As stated in Title 34, the goal is to sustain natural production "...at levels not less than twice the average levels attained during the period of 1967-1991..." To attach numeric values to this goal, we need to estimate average levels of production. One problem is that average is not a precise statistical term. In statistics, the term average can apply to several measures of central tendency (Langley 1971). The most commonly used measure of central tendency is the arithmetic mean (Lapin 1975). Consequently, the public generally understands average to mean arithmetic mean and it is reasonable to assume that this was the intent of the authors of Title 34. Therefore, **the definition of average will be the arithmetic mean.**

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INTENT OF TITLE 34

Habitat Restoration

Of the six purposes of Title 34, three are particularly germane to discussion of the intent of Title 34 as it relates to the Program. These three purposes are listed below:

(1) to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California (3402[a]);

(2) to address impacts of the Central Valley Project on fish, wildlife and associated habitats (3402[b]);

(3) to contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (3402[e]);

In addition, Section 3406(b)(1)(A) states that the Program "...shall give first priority to measures which protect and restore natural channel and riparian habitat values through habitat restoration actions, modifications to Central Valley Project operations, and implementation of the supporting measures mandated by this subsection..." Because Title 34 directs that the Program shall emphasize habitat restoration, **emphasis will be placed on restoring habitat.**

Natural versus Hatchery Production

Title 34 requires that "...natural production of anadromous fish in Central Valley rivers and streams be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967-1991..." (Section 3406[b][1]). The requirement that natural production be sustainable on a long-term basis suggests that the intent of Title 34 is for the definition of natural production to extend between generations of fish. Natural production should be self-sustaining. **The Program should not depend on hatchery-produced fish to sustain populations of naturally spawning fish.**

In addition, Title 34 requires investigations of "...opportunities for additional hatchery production to mitigate the impacts of water development and operations on, or enhance efforts to increase Central Valley fisheries; Provided, That additional hatchery production shall only be used to supplement or to re-establish natural production while avoiding adverse effects on remaining wild stocks" (Section 3406[e][2]). This section provides insight into the intent of Title 34 as it relates to the roles of natural and hatchery production and emphasizes avoiding adverse effects of hatchery production on wild (naturally produced) stocks. Under Title 34, **hatchery production should only be used as a last resort to supplement or to re-**

establish natural production, and then only after investigations on the desirability of developing and implementing additional hatchery production.

Adverse effects of hatchery production on natural stocks can include reductions in population size caused by competition, predation, disease or other factors (Sholes and Hallock 1979, Waples 1991). A large potential for negative interaction exists when these stocks interbreed (Hindar et al. 1991, Taylor 1991, Waples 1991). The adverse effects of interbreeding increase as hatchery-produced fish become more prevalent in the naturally spawning population. Interbreeding reduces interpopulation diversity and may lead to a reduction in overall productivity and a greater vulnerability to environmental change (Waples 1991). Outbreeding depression may also result from interbreeding. In addition, large populations of hatchery-produced fish that are indistinguishable from naturally produced fish may intensify effects of harvest on naturally produced fish (Wright 1993). The simplest way to avoid adverse effects on naturally produced stocks is to minimize the opportunities for interaction between naturally and hatchery-produced fish. **The Program should be designed to avoid adverse effects of hatchery production on natural stocks.**

Harvest

Title 34 does not directly address harvest. Title 34 defines natural production as: "... fish produced to adulthood..." (Section 3403[h]) and requires that natural production be increased. Inclusion of the term production, and especially production to adulthood, suggests that **Title 34 does not intend for restriction of harvest to be used as a means of achieving Program goals.** As stated in the definition of production, harvested fish should be included in counts of production. Sound harvest management is designed to harvest only excess production, allowing for enough fish to escape harvest to maintain production at the highest level the habitat can support.

Title 34 requires that natural production be increased. There are two mechanisms by which natural production can be increased: (1) increasing the productivity of the existing habitat, and (2) increasing the amount of habitat. These mechanisms are consistent with the emphasis Title 34 places on habitat restoration. Doubling productivity of existing habitat would provide more offspring from the same number of spawners. If existing spawning habitat is being fully utilized, then increasing the number of spawners by reducing harvest would not increase production. If production of naturally produced fish is doubled and escapement is held to present levels, then harvest of naturally produced fish could more than double.

The second mechanism, doubling the amount of habitat, would accommodate twice the number of spawners. This would also provide twice the number of offspring. Under this scenario, harvest of naturally produced fish could double. Under either mechanism, barring other harvest restrictions, we would expect at least a doubling of

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harvest of naturally produced fish. To meet the Intent of Title 34, **harvest should be maintained at levels that allow sufficient numbers of naturally produced fish to spawn to meet goals for at least doubling natural production.**

IMPLEMENTATION CRITERIA

As stated earlier, criteria for determination of natural production will conform to the definition of natural production and intent of Title 34, including definitions and interpretations of intent discussed and refined in this Position Paper. Because determination of natural production in the past will require different criteria than in the future, criteria for these time periods will be discussed separately.

Criteria for the baseline period

In the past, data collection efforts have not focused on estimating natural production and existing data may not provide direct estimates of natural production. In order to establish numerical goals for the Program, average levels of natural production must be estimated for the baseline period. Estimates will require assessing existing data and developing criteria to determine which data are germane. Criteria may not strictly conform to the definitions in and intent of Title 34 but are a compromise necessitated by a lack of data on natural production.

As explained in the POA, the Core Group and technical teams are responsible for developing these criteria. Technical teams are asked to develop initial criteria and estimates of average levels of natural production for the baseline period.

Where data are lacking, technical teams will make assumptions to expand existing data, or put existing data in perspective. For example, run-size estimates for American shad exist for only two years. In addition, young American shad abundance has been sampled during the fall emigration each year since 1967, except for 1974 and 1979 (Mills and Fisher, in preparation). The American shad technical team could look at young American shad abundance data to determine if run-size estimates for adults are representative of the abundance of shad for the baseline period. This approach has assumptions (chief among these is that abundance of young American shad can tell us something about average adult run-sizes) which are probably violated to some degree and is only presented as an example of what might be considered. Technical teams will document options considered for estimating natural production in issue papers that will be appended to the Program Plan if not in the text. Data quantity and applicability toward estimating natural production varies between species and drainage. Each technical team will need to address these issues for each species and drainage separately. Criteria for determining natural production during the baseline period will be applicable to existing data.

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Because there is a relative wealth of data for chinook salmon and because several Teams deal with chinook salmon, specific criteria are proposed for them. Most of the data necessary to estimate production of each stock of chinook salmon for the baseline period are compiled in Mills and Fisher (1994). The proposed procedure for estimating yearly production of each race of chinook salmon for each stream during the baseline period follows.

In the following explanations and formulas, P is for production, E is for escapement, H is for harvest, and *h* is for the portion of total production not produced naturally. Subscripted letters following the normal letters and prior to the first comma represent different races of chinook salmon as follows: F for fall, L for late-fall, W for winter, S for spring, and C for all races combined. Subscripted letters following the first comma represent the following: O for ocean, D for downstream, I for instream, N for natural, H for hatchery, and T for total. Subscripted letters following the second comma represent the following: CV for Central Valley, SF for San Francisco, M for Monterey, and other letter combinations correspond to specific streams (e.g., AM for American River). Subscripted letters following a third comma refer only to ocean harvest and are C for commercial and R for recreational. In all cases, a subscripted X acts as a "wildcard" place holder for an unspecified subscript.

1. A portion of production returns to spawn in each stream, both naturally and in the hatchery. Some of these fish are captured before spawning. These fish are counted toward production for the stream in which they spawned or were harvested according to the following:

    a. To determine the total spawning escapement ($E_{X,T,XX}$) for each race in each individual stream, sum the estimated number of each race of chinook salmon returning to spawn naturally ($E_{X,N,XX}$) and in hatcheries ($E_{X,H,XX}$) for each individual stream.

$$E_{X,T,XX} = E_{X,N,XX} + E_{X,H,XX}$$

    b. To determine the portion of production for each race returning to each stream (in-river run-size, $P_{X,I,XX}$), add $E_{X,T,XX}$ to the estimated number of each race of chinook salmon harvested in each stream ($H_{X,I,XX}$). Estimates of $H_{X,I,XX}$ do not exist for all streams and all years. Where estimates are not available or are inadequate, best professional judgement must be used. Technical Teams should document options considered for estimation of $H_{X,I,XX}$ in the Program Plan or in issue papers that will be appended to the Program Plan.

$$P_{X,I,XX} = E_{X,T,XX} + H_{X,I,XX}$$

c. To determine the total number of each race of chinook salmon returning to the Central Valley ($P_{X,I,CV}$), sum $P_{X,I,XX}$ for all streams in the Central Valley ($\sum P_{X,I,XX}$) .

$$P_{X,I,CV} = \sum P_{X,I,XX}$$

d. To determine the total number of chinook salmon (all races combined) returning to the Central Valley ($P_{C,I,CV}$), sum $P_{X,I,CV}$ for all races of chinook salmon ($\sum P_{X,I,CV}$) .

$$P_{C,I,CV} = \sum P_{X,I,CV}$$

2. A portion of production is harvested in the ocean and downstream of areas in rivers where the stream responsible for this production is not easily identified. To assign these harvested salmon to individual streams, the total number of salmon falling into this category is summed and subdivided to race and stream, proportional to the portion of production attributed to each race and returning to each stream, according to the following:

a. To determine the Central Valley component of ocean harvest ($H_{C,O,CV}$), sum commercial catch at San Francisco ($H_{C,O,SF,C}$) and Monterey ($H_{C,O,M,C}$), sum recreational catch at these same ports ($H_{C,O,SF,R} + H_{C,O,M,R}$), and add these together. This estimate of $H_{C,O,CV}$ is based on the Central Valley Index (CVI), where harvest of Central Valley stocks equals landings at major ports south of Point Arena (San Francisco and Monterey). Use of CVI to estimate the Central Valley component of ocean harvest assumes that the number of Central Valley chinook salmon harvested from ports north of San Francisco is balanced by the number of chinook salmon from drainages north of the Central Valley harvested from San Francisco and Monterey. To carry $H_{C,O,CV}$ forward in subsequent calculations, assume that each chinook salmon harvested in the ocean fishery is equivalent to an adult salmon returning to spawn.

$$H_{C,O,CV} = H_{C,O,SF,C} + H_{C,O,M,C} + H_{C,O,SF,R} + H_{C,O,M,R}$$

b. To account for that portion of inland harvest that occurs downstream of streams for which production is being estimated, estimate portion of inland recreational harvest captured downstream of spawning streams ($H_{C,D,CV}$). Information necessary to estimate $H_{C,D,CV}$ may not be available. If an estimate exists, use it. If an estimate of inland harvest for the entire Central Valley exists ($H_{X,I,CV}$), then sum all assignable inland harvest ($\sum H_{X,I,XX}$) and subtract it from $H_{X,I,CV}$ to determine $H_{C,D,CV}$. If other options exist, these should be explored. $H_{C,D,CV}$ could be assumed to be small and therefore left out of the

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calculations or could be included in $H_{X,I,XX}$, in which case it would already to assigned to an individual stream.

c. To determine ocean and downstream inland harvest for the Central Valley ($H_{C,O+D,CV}$), sum $H_{C,O,CV}$ and $H_{C,D,CV}$.

$$H_{C,O+D,CV} = H_{C,O,CV} + H_{C,D,CV}$$

d. To assign portions of $H_{C,O+D,CV}$ to specific races, subdivide $H_{C,O+D,CV}$ to each race, proportional to the portion of production for each race returning to the entire Central Valley ($P_{X,I,CV}$) to the portion of production for all races combined returning to the entire Central Valley ($P_{X,I,CV}$).

$$H_{X,O+D,CV} = H_{C,O+D,CV} \cdot (P_{X,I,CV}/P_{C,I,CV})$$

e. To assign portions of $H_{X,O+D,CV}$ to specific streams, subdivide $H_{X,O+D,CV}$ to each stream, proportional to the portion of production for that race returning to each stream ($P_{X,I,XX}$) to the portion of production for that race returning to the entire Central Valley ($P_{X,I,CV}$).

$$H_{X,O+D,XX} = H_{X,O+D,CV} \cdot (P_{X,I,XX}/P_{X,I,CV})$$

3. To determine total production for each race and stream ($P_{X,T,XX}$), sum $P_{X,I,XX}$ and $H_{X,O+D,XX}$.

$$P_{X,T,XX} = P_{X,I,XX} + H_{X,O+D,XX}$$

4. A portion of the total production was not produced naturally (*h*). For the baseline period, only hatchery-produced salmon will be considered to be produced by other than natural means. To determine the natural production for each individual stream ($P_{X,N,XX}$), multiply $P_{X,T,XX}$ by (1-*h*). Technical Teams should document options considered and chosen for estimation of *h* in issue papers that will be appended to the Program Plan or in the text for the Program Plan.

$$P_{X,N,XX} = P_{X,T,XX} \cdot (1-h)$$

Numeric restoration goals for chinook salmon in each stream will be calculated as at least double the average of $P_{X,N,XX}$ for each of the years during the baseline period.

Criteria for the future

In the future, opportunities exist to improve estimates of natural production. These range from augmenting historic data collection activities with efforts to estimate the proportion of fish that are naturally produced, to designing new data collection to better account for natural production. The Core Group and technical teams are responsible for designing future monitoring programs.

The Core Group and technical teams have and will identify deficiencies in the baseline data. Future monitoring activities will be designed to address and avoid deficiencies. For example, monitoring programs should focus on estimating production, including harvest, on a consistent and regular basis, preferably yearly, in all of the streams in the Central Valley.

Monitoring programs should also estimate natural production, requiring some means of separating naturally produced fish from fish produced by other than natural means. At the very least, natural production must be discernable from hatchery production. Several methods can be used to separate naturally produced fish from hatchery-produced fish, including use of scale (Scarnecchia and Wagner 1980) or otolith (Paragamian et al. 1992) characteristics and constant fractional (Hankin 1982) or complete marking of hatchery-produced fish (Wright 1993), including incorporation of genetic markers (Waples 1991), inducement of otolith banding patterns (Volk et al. 1990), and more standard methods such as clipping fins. In addition, recommendations for the future should include managing naturally and hatchery-produced fish separately.

In addition, better estimates of harvest of Central Valley salmon in the ocean and of all anadromous fish in the Bay, Delta, and in each individual river and stream in the Central Valley should be developed. Harvest should be monitored continually.

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D. Summary of information used to prioritize watersheds.

Table D-1. Production target for chinnok salmon, presence of CVP flow control stuctures or facilities, and race or species present in each of the watershed for which actions are listed in this restoration plan.

River	Chinook salmon production target	CVP influence	Winter run	Spring run	Steelhead	Late-fall run	San Joaquin fall run	Fall run	Green sturgeon	White sturgeon	Striped bass	American shad
Sacramento River	990,000	X	X	X	X	X		X	X	X	X	X
Clear Creek	7,100	X		X	X			X				
Cow Creek	4,600				X			X				
Cottonwood Creek	5,900			X	X	X		X				
Battle Creek	10,550	X	X	X	X	X		X				
Paynes Creek	330				X			X				
Antelope Creek	720			X	X	X		X				
Mill Creek	8,600			X	X	X		X				
Deer Creek	8,000			X	X	X		X				
Misc. creeks	1,100				X			X				
Butte Creek	3,500			X	X	X		X				
Big Chico Creek	800			X	X	X		X				
Feather River	170,000				X			X	X	X	X	X
Yuba River	66,000			X	X			X				X
Bear River	450				X			X	X	X		

River	Chinook salmon production target	CVP influence	Winter run	Spring run	Steelhead	Late-fall run	San Joaquin fall run	Fall run	Green sturgeon	White sturgeon	Striped bass	American shad
American River	160,000	X			X			X			X	X
Mokelumne River	9,300				X			X			X	X
Cosumnes River	3,300							X				
Calaveras River	2,200		X					X				
Merced River	4,500				X	X	X					
Tuolumne River	38,000					X	X					
Stanislaus River	22,000	X			X	X	X				X	X
San Joaquin River	0	X					X		?	X	X	X
Sacramento-San Joaquin Delta	0	X	X	X	X	X	X	X	X	X	X	X

E. List of acronyms.

(Will be included in next draft.)

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